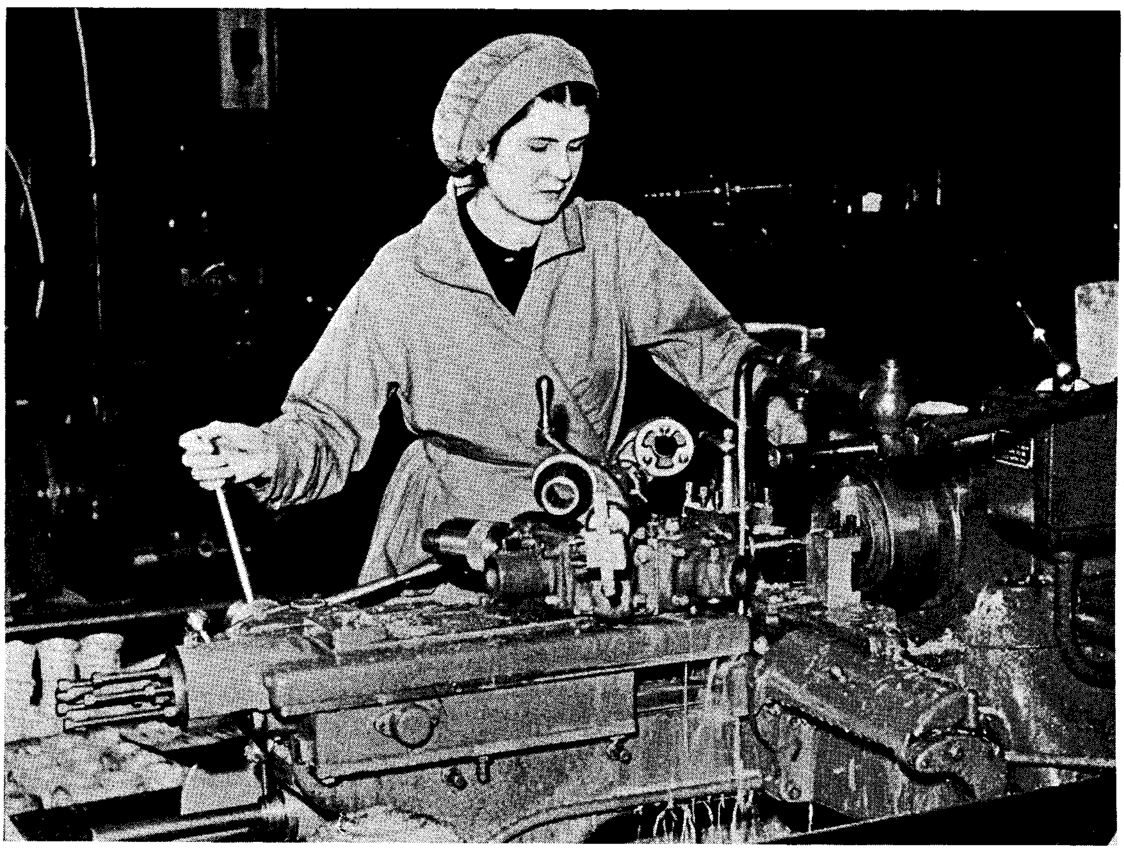
Internal Back-gear for a Small Lathe

THE MODEL ENGINEER

Vol. 82 No. 2027 • THURS., MARCH 14, 1940 • SIXPENCE

In this issue

Another of Mr. Winston Churchill's "million munition girls," operating a Herbert capstan lathe in a British engineering factory. *(Photo by courtesy of Messrs. Alfred Herbert, Ltd.)*



THE MODEL ENGINEER

Vol. 82 No. 2027

March 14th, 1940

60 Kingsway, London, W.C.2

Smoke Rings

Model Locomotive Contest Continued

WITH commendable enterprise, the Romford Model Engineering Club have decided to hold another contest, the conditions of which are to be generally similar to those that governed last year's contest. Mr. Henderson's offer of £1 1s. has been supplemented by the addition of a similar amount from the Club's own funds. The Committee, however, would welcome any suggestions from our readers. Mr. W. B. Hart's article in our issue of February 29th, contained some useful hints that, no doubt, will be duly considered by the organisers of the contest. But, as Mr. Hart points out, the recording of the load hauled, and the speed at which it was hauled, is of little value unless all the conditions under which the run was made are also recorded. For example, the performance of miniature locomotives would appear to be more markedly influenced by weather and the state of the track than are the prototypes; and this seems to offer a big field for exploration, though, of course, this cannot be done during an actual competition. What is required is some information that could be used for the purpose of assessing a sort of handicap upon each individual locomotive during the contest. Such information can become available only by carefully noting the weather and track conditions each time the locomotive is run when no competition is being held. Most owners of miniature locomotives have more than a vague idea of what those locomotives are capable of doing when running, but few men have taken the trouble to note just what differences in performance occur when external conditions vary. Some systematic recording of this kind would be of inestimable value when locomotives are entered for trials of any sort. There is a further matter that follows upon all this; the effect of external conditions becomes more pronounced the smaller the locomotives. This suggests that there is some reason for classifying miniature locomotives, in competition, to a greater extent than is done at the moment. Readers views on this, and the other matters alluded to above, would be interesting and useful.

One Thing Leads to Another

IN model engineering, as in all other crafts, a question that is for ever presenting itself is: What are the best tools to use for this little job? It is not too much to say, perhaps, that every model engineer has, some time or other, found it necessary to devise some special apparatus or method for doing some special job. An example is seen in the special small planes that Mr. L. H. Sparey illustrated and described in our issue for February 15th last; these were devised and made specially for the purpose of overcoming a difficulty that arose during the construction of a model aeroplane, and they proved their worth. Many other instances of this kind of thing could be quoted; and that is one reason why the home workshop can be a never-ending source of interest and an unfailing outlet for one's ingenuity and resourcefulness, not to mention the adding of variety to the particular job in hand. Adaptations of existing equipment, such as, for example, devices to enable milling-cutting to be done on lathes, are simply innumerable, and literally hundreds of them have been described in back numbers of the "M.E." No two of them are exactly alike, yet most of them are essentially the same; some are on the market, as a glance through our advertisers' catalogues will show. In fact, milling-cutters for lathes would seem to be one of the most popular and useful of the amateur's possessions, yet new forms of these particular devices are constantly being made. All this, incidentally, raises the point that published descriptions of models are always more interesting to the majority of our readers if any special tools or apparatus, required in the construction of the models, is fully described and illustrated. The old adage quoted as the heading to this paragraph, finds no more practical demonstration than in the workshop of the amateur craftsman; and the charm and attraction of model engineering, as a whole, very largely depend on it.

Percival Marshall

Model Engineers and National Service

*Capstan and turret lathes

By Edgar T. Westbury

Lubrication

THIS term refers, in the present case, to the application of oil or cutting compound to the work and the cutting tools, rather than running lubrication to the bearings, though the latter is by no means unimportant in view of the heavy duty to which these machines are subjected. As shown in previous articles, some capstan and turret lathes have provision for forced lubrication to the more important bearings, while others have ring-oilers, oil baths, or similar devices for ensuring a supply of oil to the mandrel bearings; and oiling devices are sometimes provided on the various slides and motion bearings.

The desirability of flushing the work and the tools with a copious supply of a suitable fluid is fully established among all users of machine tools, but it is by no means certain that the choice of the term " lubrication " to describe it is a very happy one, though it seems to be the only term capable of universal application. In fact, it may be said that considerable confusion appears to exist about the entire subject as to the specific function of the fluids thus applied, and of the most suitable or efficient fluid to use for a particular purpose.

It is not sufficient to say that the purpose of the so-called " lubricant " is simply to conduct away the heat generated by the cutting action of the tool. While this is quite true in a general way, the statement does not go far enough, and leaves entirely unexplained the reasons why different cutting mediums should be necessary, or at anyrate desirable.

Undoubtedly, the major part of the problem is to remove as much heat as possible in the shortest time. While this does not constitute lubrication in the true theoretical sense, it should be remembered that in many modern systems of forced lubrication on high-efficiency engines, for instance, the oil is flushed rapidly through the bearings, and constitutes a medium for conducting away heat, as well as a true lubricant. But in respect of the function of a lubricant in forming a separating film between two metal surfaces in relative motion, and thus prevent them from coming into actual contact, this is the very last thing to be desired in the case of a cutting fluid, and every authority on the subject admits that the best lubricant constitutes the poorest cutting fluid. The term " coolant," or in some cases " refrigerant," more correctly describes the function of liquids designed for this purpose.

According to well-known physical laws, the fluid best adapted to the purpose of conducting away heat is that having the highest " specific heat," or capacity of a given mass to absorb thermal units in a given time. From this point of view, it would appear that water is the best cutting fluid, but in actual practice there are many disadvantages in using it, at anyrate by itself. First, there is the objection that it washes away oil from running and sliding bearings, and tends to set up corrosion of the work, tools and machine. A further disadvantage, which is by no means so obvious, is that its high surface tension tends to prevent it from readily making the most intimate contact with the metal; it tends to coalesce into drops instead of forming an even film. Its comparatively low boiling point at atmospheric pressure is also a disadvantage in cases where, for various reasons, a fairly considerable rise in temperature is inevitable.

Cutting Emulsions

Water is, however, the conducting medium in most of the cutting fluids in use at present, but its wetting effect is considerably improved by the addition of alkaline or oily constituents, which also act as rust preventatives. The science of compounding these cutting fluids, and also their selection for various classes of work, has been very largely empirical, and has also been considerably influenced by the commercial economics of the substances available for the purpose. By-products from oil refining, soap making and chemical industries have been applied, sometimes with unanticipated and not too happy results.

It has, however, been recognised in recent years that the increasingly exacting duties of modern machines and cutting tools demand something better than the haphazard methods of selecting cutting fluids which have prevailed in the past, and as a result, a great deal of research has been undertaken with a view to eliminating the known disadvantages of existing fluids.

It is well known that in ordinary circumstances, oils and fats will not mix with water, but tend to separate out completely almost immediately after mechanical mixing. If, however, the oil is saponified by the chemical action of alkaline or other solvents, it will remain in more or less stable suspension, forming a milky fluid or " emulsion " when mixed with water. This is the principle employed in cutting fluids, but it has not always been found possible to produce mixtures which are

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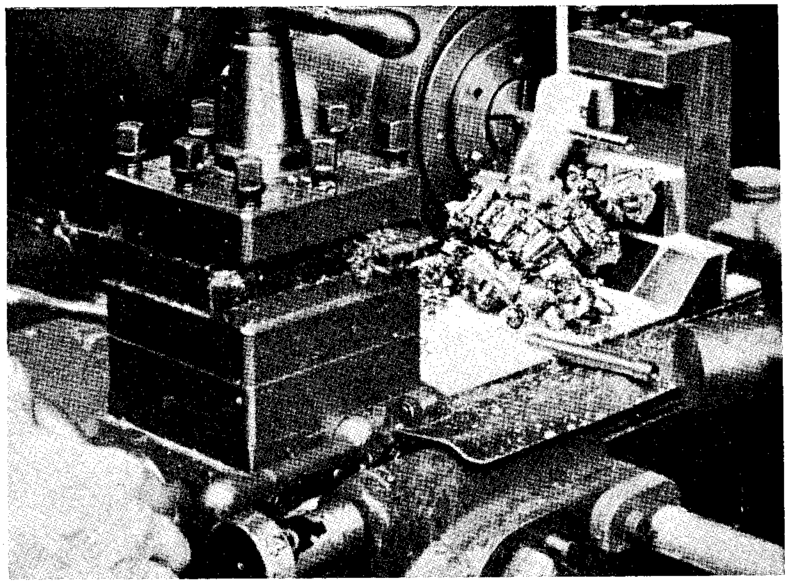
* *Continued from page* 252, " *M.E.,*" *March* 7, 1940.



A forming operation on a capstan lathe, showing the use of "Sternopal" cutting fluid.

in every way satisfactory. Some emulsions are not truly stable, and tend to separate out after a time, leaving a gummy residue in tanks and pipes, which may cause trouble with pumps and service systems; the decomposition of animal and vegetable fats may give rise to offensive smells, or tend to cause skin diseases among workers; while the presence of impurities may cause chemical action and set up tarnishing, discoloration or rust in metals with which the fluid comes in contact.

Nearly all modern cutting fluids, however, are free from these disadvantages, and are, moreover, compounded specifically to suit various classes of work. One of the disadvantages of ordinary milky emulsions is the obscuring of visibility, so that it is impossible to properly observe the cutting action of the tool; but this can be eliminated nowadays by the use of special transparent emulsions, such as "Sternopal" (Messrs. Sternol, Ltd.) and " Hocut " (Edgar Vaughan & Co., Ltd.). For more general purposes, where this disadvantage does not seriously arise, the above firms recommend a comprehensive range of compounds, including " Sternol 20 " and " Sternol Elite " by the former firm, and " Solcut " and " Permasol " by the latter. Advice as to the suitability of any of these for specific classes of work is readily given.

" Straight " Cutting Oils

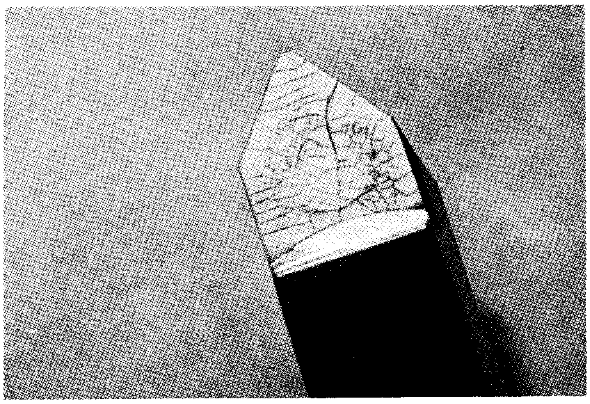
There are some purposes where a water-soluble cutting fluid fails to fulfil the requirements of exacting duties, as, for instance, extremely rapid production in very tough metals, and in such cases it is found better to use a " neat " oil which has the property of clinging much better to metal surfaces than an emulsion, and also has a much higher boiling point. Various types of animal, vegetable and mineral oils have been employed, either singly or in combination, for this purpose, and one of the most widely used is lard oil. This is sometimes diluted by the admixture of a thin mineral oil such as paraffin, though the inflammability (low flash point) of the latter is a serious disadvantage in cases where much heat is generated. Modern cutting oils are not usually raw products, but are compounded strictly with regard to the class of work for which they are intended, some being designed for heavy screwcutting, some for tapping and drilling, some for machining non-ferrous metals, and so on. A comparatively recent development is the use of " sulphurised " oils, which have many advantages over the raw base oils previously used. It is often found that the use of oil enables finer finish to be obtained, and the cutting edge of the tool to be retained longer, than with emulsified compounds, though it may be observed that the improvements in the latter have made it possible to employ them for many duties for which only oil had formerly been considered suitable. The name of E. F. Houghton & Co. has always been associated with cutting oils, and their " Cut-Max " series of oils provides a range suitable for all modern requirements. The " Frapol " cutting oils are made in a similar range, and both these brands are marketed by Messrs. Edgar Vaughan & Co., Ltd.

Whether oils or emulsions are employed, the permissible rate of cutting depends upon the lowness of temperature which can be permanently maintained at the actual tool point. If the work could be done with no rise of temperature whatever, there is no theoretical limit to the rate at which metal could be removed, other than the power applied to the lathe, and the mechanical strength and rigidity of the essential parts. But in practice, it is quite impossible to prevent local heating, however rapidly the fluid is circulated, and it is by no means uncommon, in cases of tool failure, to find that the chip has become welded solidly to the tool point. It is probable that this condition only arises after considerable blunting of the edge, which thus sets up excessive heating; but the fact remains that the primary condition is itself largely avoidable by the correct use of a really suitable cutting fluid.

Tool Steels

The question often arises, what is the best tool steel for use on capstan and turret lathes? This, again, does not allow of a direct answer, as so

much depends upon the material to be machined, the nature of the machining and several other conditions. One of the most vital factors in tool performance is the temperature which the cutting edge is called upon to withstand, and thus the tool steel problem is to some extent interdependent with that of lubrication or cooling.



An Ardoloy tipped tool, showing cracks caused by overheating during grinding.

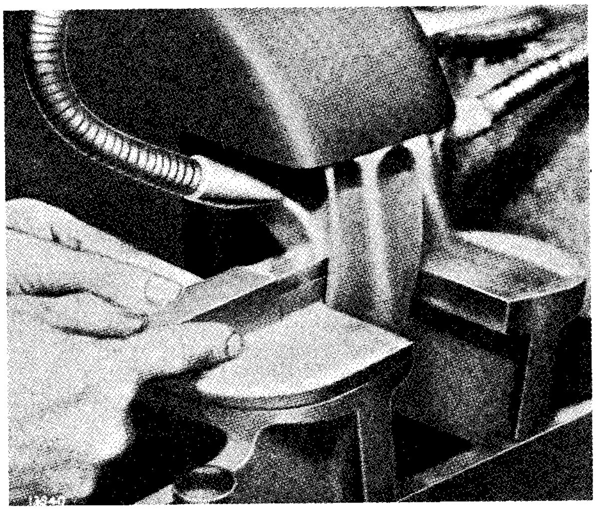
If cutting tools were only required to work at normal temperatures, it follows that any steel which provided the necessary hardness, resistance to wear, and structural strength, would be suitable for the heaviest duty. Ordinary carbon steel (i.e., iron alloyed with a sufficient proportion of carbon to harden by quenching) fulfils this condition fairly well, and has the further advantage that the final hardness is under complete control by tempering. It is thus quite suitable for a lathe tool steel within certain definite limits of duty, and is used extensively for light work.

When any appreciable heating of the tool point occurs, however, the tool point becomes softened, due to the progressive tempering action, and the tool is thus rendered useless. It has thus been found necessary to develop special " high speed " steels, which have the quality of retaining their initial hardness up to much higher temperatures than can be tolerated in the case of carbon steel. The best modern tool steels will, in fact, retain their cutting edge even when actually red hot, and it is this state of " Red Hardness " which is so essential in tools for high speed work.

Most high speed steels are hardened at a very much higher temperature than is necessary, or even permissible, for carbon steel; it is usual to heat them to about 1,250° to 1,350° C., and cool out in oil or in a dry air blast Water quenching would almost inevitably produce cracks. Secondary hardening, or high temperature tempering, while not absolutely necessary, is often carried out to relieve hardening strains and increase toughness. This consists of re-heating the steel to 550° to 640° C. (according to grade and purpose), in some cases maintaining this heat for varying periods, and cooling naturally. It is possible to harden high speed steel at much lower temperature than that stated, but only at the expense of its special virtues in respect of heat resistance.

Forging of high speed steel is carried out in much the same way as for carbon steel, but at rather higher temperatures, as it is inadvisable to attempt to work the steel at anything below a bright red heat (900° C.). Slow and even heating are most essential, and the blast must not be allowed to impinge directly on the steel; the cooling should also take place slowly in still dry air.

Many high speed tools are simply ground to shape from bar in the hardened state, requiring no forging or hardening. It is by no means uncommon for tools to be ruined by faulty grinding, especially if unsuitable abrasive wheels are used, and the tools are allowed to heat up in grinding. The practice of cooling out the tool in water after heat has thus been generated is almost certain to result in the formation of cracks. A water-cooled wheel should be used, with a sufficiently copious supply of coolant to keep the temperature from rising appreciably. After hardening, the surface of a tool may become decarburised for a depth of as much as 1/32", and this must be completely ground away before the tool is put into service.



An abrasive wheel of the correct grade, and an ample supply of coolant, are important essentials for grinding high speed steel tools, and even more so in the case of tungsten carbide tipped tools.

There are innumerable makes of high speed steel now available, all of which have their own special merits, and it would be almost impossible to deal with them all in detail. Machine shops nearly always have their own particular favourites —some swear by one make, others swear at another—which is all right as far as it goes, but it would be a mistake to assume that any one type of steel can be equally efficient for every purpose.

(To be continued)

*Gauges and Gauging

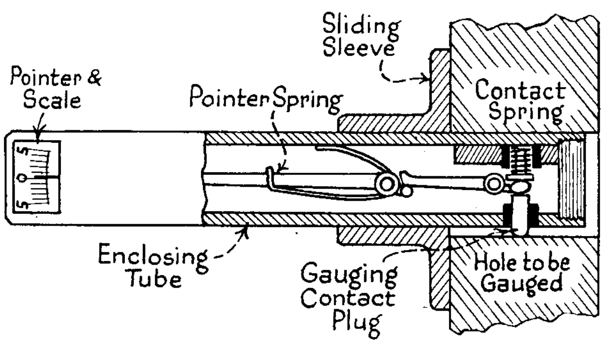
A series of great value to engineers of all classes, particularly those who are engaged upon national service

By R. Barnard Way

Indicating Gauges

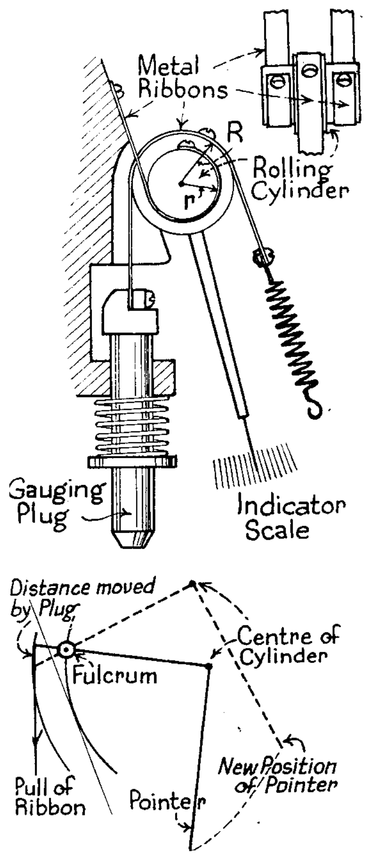
IN our previous article we examined a variety of gauging tools in which some kind of visible indication is given as to the dimension of the specimen under examinaton. This indication, as we saw, might be viewed in the case of some of these devices, but in others it is better judged by the sense of touch. Of these, there is a considerable variety, and it is only possible to generalise with regard to them, for it is necessary to construct special appliances to deal with every separate piece that has to be so gauged. In a sense, of course, this applies to every gauging device for special use. As space is limited in these pages, we shall have to concentrate upon principles as far as we can, only illustrating examples that display those principles in the clearest way.

With regard to the illustrations, we feel that some explanation—and apology—is due to the reader. While we make every endeavour to ensure a fair degree of accuracy, it is not always possible to make exact drawings of the interior arrangement of some of the gauging devices, interesting though they may be. It is possible to make diagrams to show *how* they work, though these diagrams must not be assumed to illustrate the exact arrangement. The writer has had the privilege of examining many of these machines and other appliances, and in his workshop days, the opportunity of studying their use. An enormous collection of notes and material, the accumulation of half a lifetime, is available to draw upon, but we must acknowledge our indebtedness to the pages of that invaluable paper, *Machinery,* with its clear and concise drawings so well known to every mechanic who believes in his star. With these preliminary remarks, let us now go on to look at a few more of these appliances.



Another type of multiplying lever comparator for gauging the diameter of holes.

The multiplying lever indicators are the most numerous of all, perhaps, and their applications are endless; we shall show a few of these presently. Here is another one to add to the assortment already shown, this is for gauging the variation from standard of a round hole. The drawing is made in part section, from which it can be seen that it is made in tubular form. On this casing is a sliding sleeve, with a flanged face, finished with precision at right-angles to the axis of the appliance. The object of this is to ensure that proper contact is made between the tubular casing and the hole being gauged, perhaps the drawing will make more clear the idea of this. Projecting from the casing is the contact plug, pressed outwards by a light spring, and clipped between

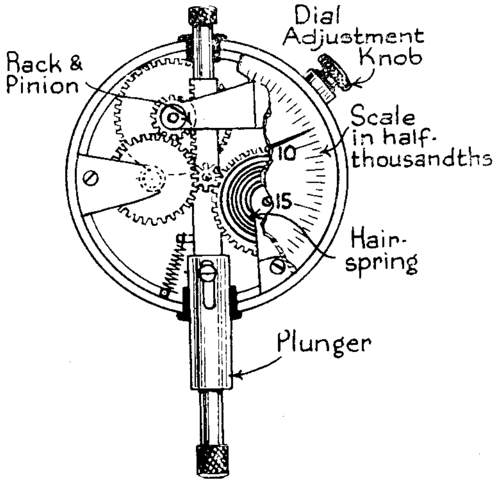


Principle of the T.T. and H. comparator.

* *Continued from page 208, "M.E.," February 29, 1940.*

the spring and the plug is the short end of a lever. Movement of the long end of this lever is imparted to the short end of a light indicating pointer lever, so that the indication given by the pointer is a much magnified version of the motion of the plug. In this case, the degree of magnification is 60 to 1.

To use a tool of this sort, it must first be inserted into a hole that is precisely finished to the correct dimension, and the reading of the pointer noted. Deviation from this reading when testing the workshop products gives a measure of their deviation



A dial gauge with train of gears.

from standard; rotation of the tool in the hole will give an indication as to the true roundness of it, and sliding it in and out at the same time gives indication as to its parallelism.

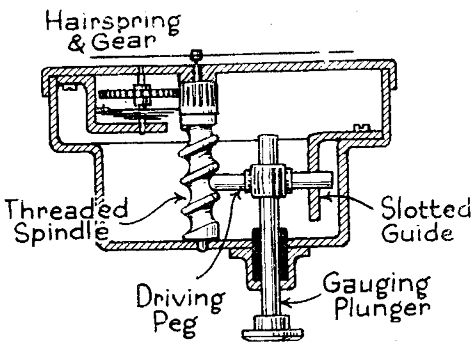
To get the best use out of a comparator of this sort, the magnification should certainly not be less than 60 times, much better 100 times. If a practical indication is to be given of a variation from standard of one thousandth of an inch, then the pointer ought to move at least one sixteenth of an inch. This represents a magnification of 62.5 times; with 100 times, the indication will be one-tenth of an inch, ample to permit of estimation of fractions of this.

The disadvantage of this type of comparator is in its liability to backlash, but the correct adjustment of the necessary springs will obviate this. A well-designed gauge will have its parts nicely balanced. and the weight of its moving levers reduced to the minimum. A most useful feature of many of these devices is an adjustment provided for bringing the pointer to zero, no matter what its indication may be. The value of this can be seen when the preliminary trial is made in the standard hole, for by setting the pointer to zero then, a positive or negative indication is more clearly obtained when testing other pieces.

With reasonable care in use, and frequent checking back to the standard piece, gauges of this sort can be invaluable in the viewing department; obviously they are of too delicate a nature for rough work. They are not to be considered as measuring devices, though a good, well-kept machine like the Hirth Minimeter can be relied upon to measure as accurately as any standard micrometer, once it has been adjusted to a standard. It can, however, only record deviations of a few thousandths of an inch plus or minus relative to that standard setting.

There is a comparator designed upon a quite novel principle, made by Taylor, Taylor & Hobson, worthy of mention here. A diagram is given to show the principle of its working; though the basis may not be at first too clear, a little thought will elucidate the mystery—that is, if we fail to shed the necessary light on it. Briefly, it consists of a little cylinder rolling on an inclined surface. The outer ends of this cylinder are turned down to a slightly reduced diameter, and it is upon these ends that it rolls. Thin metal ribbons are wound upon these surfaces and secured to them, in the manner clearly shown in the sketch, those upon the reduced diameters are secured to the sloping surface so that as the cylinder is rotated it climbs up, or rolls down, according to the direction of rotation. The ribbon on the central portion is secured at one end to the gauging plug and at the other to a spring that keeps it tight.

Movement up or down of the gauging plug thus rotates the cylinder; an upward movement rolls the cylinder down the slope, and *vice versa*. A pointer, 4″ in length, is secured to the cylinder, and a scale is provided to indicate its movement clearly. The difference between the radii of the two portions of the cylinder is a measure of the degree of magnification of this device. We have marked these two dimensions in the drawing—

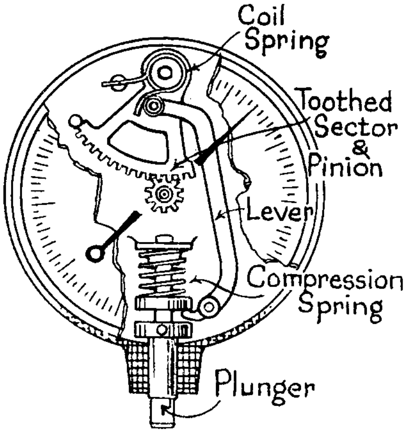


A dial gauge with helical spindle drive.

where the difference is grossly exaggerated—as R and r, and in practice this will be only 0.01″. Putting it in the form of a formula, the magnification is $\dfrac{1}{R - r}$, or with a 4″ pointer, $\dfrac{4}{R - r}$; so, with $R - r$ equal to 0.01″, we get 400 times. Why should this be so?

It looks as if an up or down movement of the gauging plug of, say, 0.01″ should move the cylinder down or up the incline by something less than the same amount, and the consequent

rotation of a cylinder of about one quarter of an inch diameter would be approximately 1/20 revolution, giving a needle deflection of about 16/100″. This is not the basis of the argument at all, as the further small sketch shows.



A dial gauge with magnifying lever.

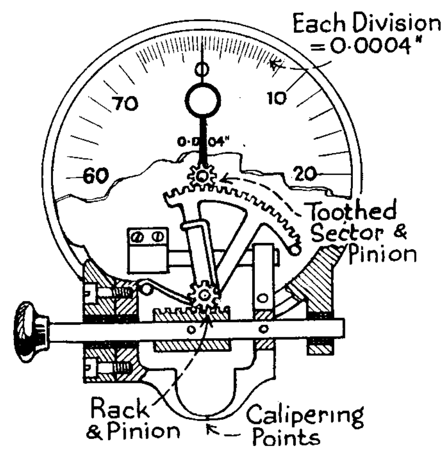
What we have is, in effect, a lever of the first order, its fulcrum at the point of contact of the ribbons on the smaller diameter, the power being exerted at the point of contact of the ribbon on the larger diameter. If the difference between these diameters (or radii) is only 0.01″, and the radius of the smaller part of the cylinder about 0.125″, then the displacement of the centre of the moving pointer is 12.5 times the movement of the gauging plug. Converting this into angular displacement of the cylinder, and magnifying it with a 4″ pointer, the track of which is a cycloid curve and not circular, the final result is an indication equal to $\frac{4}{R - r}$, or 400 as we said once before.

Let us now pass on to the very useful Dial Gauges, of which there are several types, though there is no particular object in examining them all very closely. The only difference between most of them is in the mechanism by which the vertical movement of the plunger is converted into a highly magnified rotary motion of a pointer on a scale, and this without loss or backlash. Some of them pin their faith to a straightforward chain of gears, set in motion first of all by a rack cut on the upper portion of the plunger inside the casing. One such as this we illustrate here; this has a range of movement of its plunger amounting to 0.3″, and the dial is graduated in half-thousandths. As one revolution of the pointer represents 0.05″, six revolutions cover the full range of the plunger, often in this case there may be a small dial to count the revolutions. To make the device more useful, the scale is graduated right and left of the zero point, thus a clear indication is given of variation plus or minus of a standard measurement.

Yet another valuable addition is a knob, by means of which the dial can be turned round, without interference with the pointer, so that the zero—or any other—point can be lined up with it. All these gauges are provided with a solid lug at the back, so that they can be clamped to a stand and used on the surface block. Suggestions, that we hope will be found useful, as to how such gauges can be practically employed will follow in the next article in this series.

The writer must draw upon his memory for the sketch of the next dial gauge, in which a round-nosed peg fixed to the plunger engages with the thread of a coarse worm formed on the central spindle. The angle of this worm thread permits it to be driven by the peg so as to produce rotary motion. A hair spring, as in the previous example, keeps the contact points together so as to absorb the very small degree of slackness necessary to ensure a nice freedom in working.

The third example shows a somewhat different arrangement. Here the vertical movement of the plunger is imparted to the small end of a lever, the long arm of which swings a toothed sector, in its turn engaging a small pinion on the pointer spindle. A compression spring governs the movements of the plunger, and a coil spring that of the toothed sector. The spring on the plunger is the more powerful of the two, this is necessary to ensure returning it to zero every time. One revolution of the dial pointer corresponds to a movement of 0.01″ of the plunger, and as the dial is divided into half-thousandths, it is quite easy to estimate fractions of 0.0005″.



Mechanism of a calipering dial gauge.

The last example due for mention is a gauge for calipering measurements, used by clock and watch makers. The mechanism is simple enough, consisting of a rack and pinion drive to a toothed sector and pinion. A knob and plunger is provided for opening the caliper jaws, and an extension arm keeps the alignment of the jaws true. One revolution of the pointer indicates a movement of the jaws equal to 0.080″, and the graduations are of 0.0004″.

(To be continued)

Internal Back-Gear for a Small Lathe

A description of a useful accessory that occupied many pleasant hours in its construction

By William Barlas

THE back-gear described here was made to fit a small lathe, about 2″ centres, which came into the writer's possession some time ago.

Considerable work was done on this machine in order to bring it to an accurate state, and to make it suitable for collet chucks.

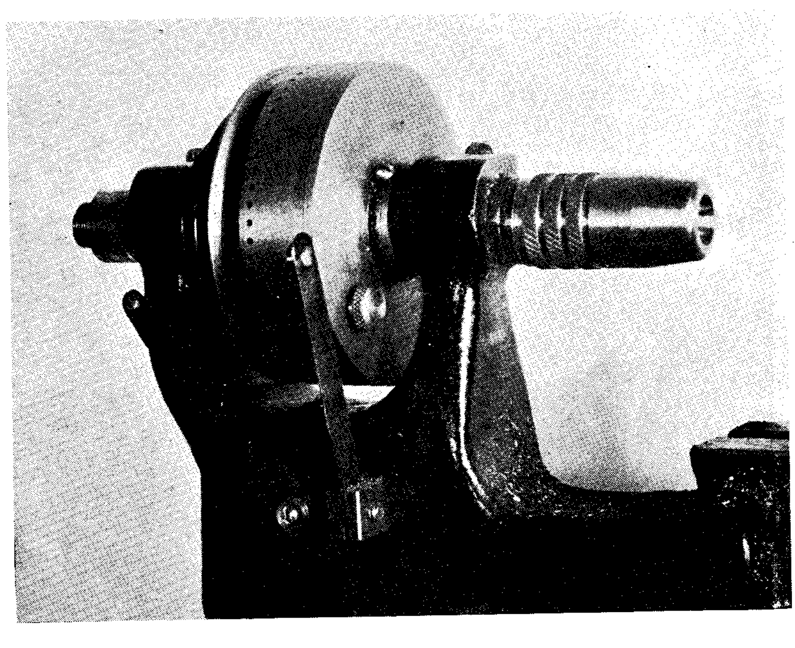
This type of gear is more difficult to make than the orthodox type, but is much neater and does not require lugs or other appendages on the headstock, usually a difficult problem to solve on an existing headstock, i.e., if the addition is to look like part of the original and not merely a bit stuck on.

The writer recollects a gear of similar type being described in the pages of THE MODEL ENGINEER during the last war, suitable for a 4″ lathe. The principle, so far as memory goes, is much the same, but the size, and possibly the construction, are different.

The ratio of cone to mandrel is, approximately, 7-1, and the size is suitable for the small baby lathes about $2\frac{1}{8}$″ centres, which are so common now, and, if fitted to such, would enable those owners who are enthusiastic locomotive constructors to turn driving wheels without much difficulty.

The writer actually turned the faceplate of his lathe on its own spindle, and the faceplate was 5″ diameter. The cut, of course, was light.

Most of the internal parts, such as the gears themselves were made from cast steel hardened in oil and ground and lapped. This makes the construction much more difficult, and is not really necessary, provided that the material from which the gears are made is strong enough. So far as this goes, good cast steel, unhardened, should be satisfactory.



The gear assembled in headstock.

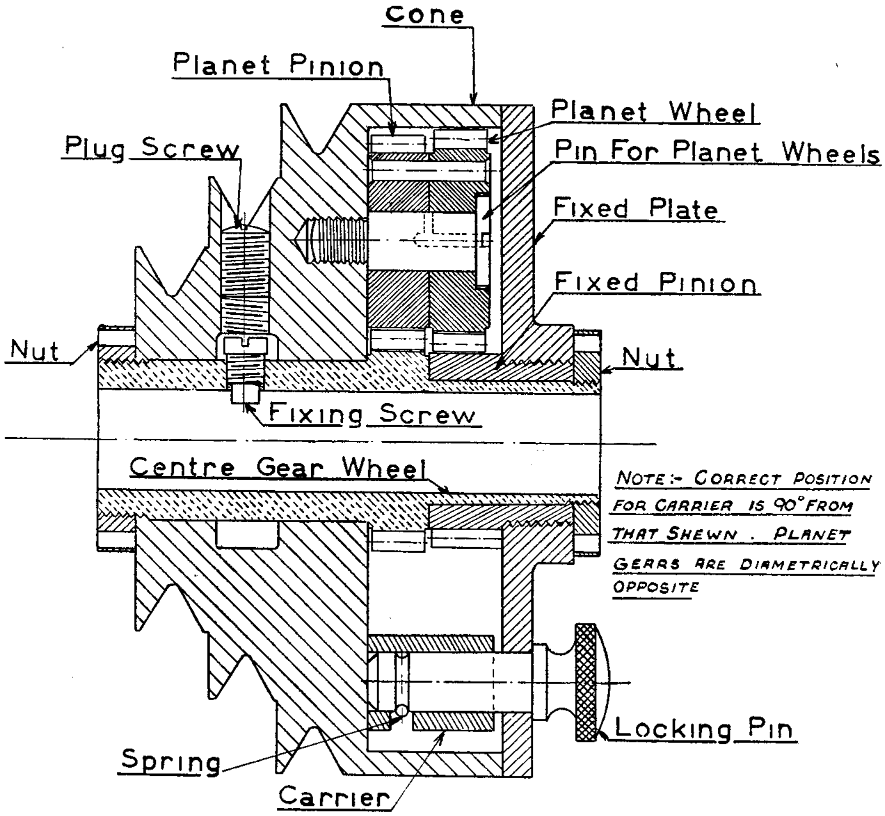
There is a slight difference in the procedure, however, if the gears are hardened, and this will be indicated under the description of the parts affected.

The Cone

This is turned from a small casting and is quite straightforward. It is seen in Fig. 1. The only operation likely to prove troublesome is the drilling and tapping of the two holes which take the planet wheel pins. It is necessary to have these accurately pitched so that the gears may mesh properly, and if the following method is used no difficulty will be experienced.

As will be seen from the drawing, the distance from centre line to centre of tapped holes is 1.0385″. Turn three discs of brass or other suitable material, 1.0385″ diameter. Two of these will be, say, $\frac{1}{4}$″ thick, and have a hole in the centre the tapping size for $\frac{1}{4}$″ B.S fine thread. The third will be 3/16″ thick, and have a spigot turned to a good fit in the 27/32″ bore of the cone. Drill a $\frac{1}{2}$″ or $\frac{3}{8}$″ hole in the centre.

The centre disc is pushed into the bore in the cone, and the other two discs placed one on either side. The discs are placed so that they are diametrically in line by applying a small rule or straight piece of material so that the three discs all lie along the rule. A bolt is passed through the bore of the cone and through the hole in the centre disc, and a large washer or clamp placed so that it reaches over the two side discs, but is clear of the centre holes. A nut run on the bolt and tightened up will clamp the two side discs down. These can be used as jigs and a drill run through the centre holes into the face of the cone. It is essential that these holes be drilled square and also tapped square. This drilling, therefore, should be done



The full size general sectional arrangement of the internal back-gear for a small lathe.

on a drilling machine or lathe. It would be advisable to start the tap also with the drilling machine, turning by hand in order to ensure that tapping is square.

The sketch, Fig. 1A, will show how the holes are positioned.

If desired, the holes for the carrier could be left out meantime, and drilled through the carr:ers after these are made. This would be a better plan, as there is then no doubt of the holes coming in.

This completes the work on the cone meantime.

The Fixed Plate

This is turned from a mild steel disc (F:g. 2), and should present no difficulty. Finish off, with the exception of the 5/16″ hole for the locking-pin. This could be drilled now, but it might be advisable to leave it to a later operation.

Centre Gear Wheel

If made in unhardened material, this part (Fig. 3) can be finished right off and the teeth cut, but if it is intended to harden, then it will be

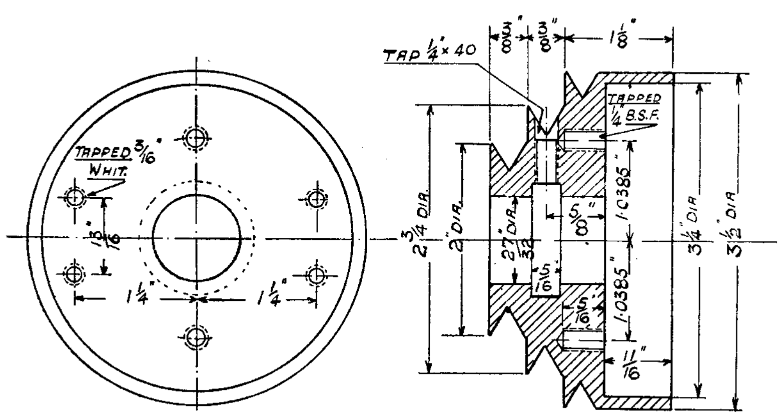


Fig. 1. Cone—1 off C.I., machined all over.

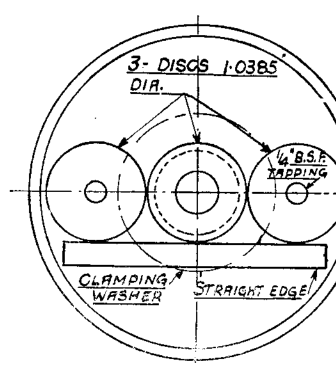


Fig. 1A. Method of drilling holes for planet pins

necessary to leave grinding allowances on all diameters which are to be ground.

The writer left, approximately, 0.005″ on the 27/32″ and 21/32″ diameters, and 0.0005″ on the bore. The latter was not ground with a wheel, as the hole was too long for the internal

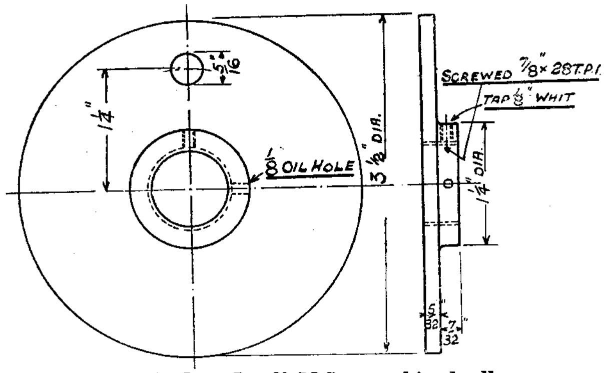


Fig. 2. Fixed plate 1 off M.S., machined all over.

grinding spindle, and was lapped a good tap fit for the spindle by means of a a split cast-iron lap.

After the turning, screwing and tapping are finished, the teeth can be cut. This completed, the hardening should be carried out, and after this the grinding and lapping.

It should be stated that, if more convenient, all the tooth cutting, etc., can be done together.

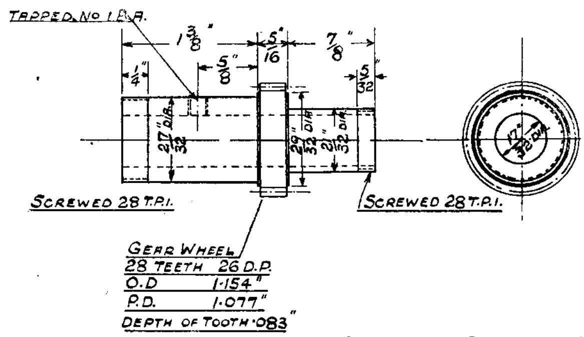
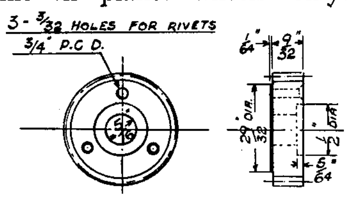


Fig. 3. Centre gear wheel 1 off, cast steel, hardened, ground and lapped.

Planet Wheels and Planet Pinions

If left soft, turn up and cut the teeth. Bore rivet holes meantime in planet wheels only.

Fig. 4. Planet wheel, 2 off cast steel; hardened 28 teeth, 26 D.P. O.D. = 1.154-in. P.D. 1.077-in.



The planet wheels are seen in Fig. 4, and the planet pinions in Fig. 5.

The holes in the pinions will be drilled through the wheels when the other parts have progressed far enough to assemble the wheels and pinions in their correct positions.

If the wheels have to be hardened, the blanks will be turned to size, but a small allowance made on the bore for grinding and lapping. Drill the three rivet holes in the wheels but do not harden yet, as this must be left until the holes are drilled in the pinions.

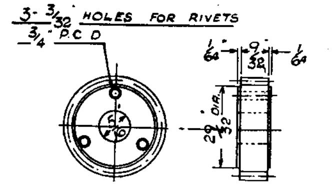


Fig. 5. Planet pinion, 2 off, cast steel, hardened, 26 teeth, 26 D.P., O.D. = 1.077-in., P.D. = 1.00-in.

Fixed Pinion

If left soft, turn, bore, and screwcut the blank. See Fig. 6. Screw into the fixed plate (tight fit), drill the oil hole through the boss of the fixed plate and dimple through the 1/8″ tapped hole in the fixed plate boss. This is to take the point of a small grub-screw, which prevents the pinion from unscrewing under load. If preferred, this pinion could be screwed in with a left-hand thread, which would be better.

If the pinion has to be hardened, turn, bore and screw, but leave grinding allowance on the bore. Screw in, drill the oil hole and dimple as before; then remove and harden, after which grind and

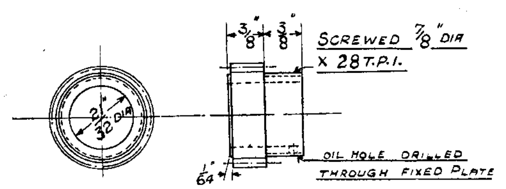


Fig. 6. Fixed pinion, 1 off cast steel, 26 teeth, 26 D.P., O.D. = 1.077-in., P.D. = 1.00-in., depth of tooth 0.83-in.

lap, bore a nice running fit for centre gear. Incidentally, cut a small oil gutter along the bore from the oil hole before hardening.

It is advisable to harden the pin for the planet wheels, Fig. 7, whether the wheels are soft or not.

The construction does not really need any description, but remember, if you are grinding and have left an allowance for this, it would be better

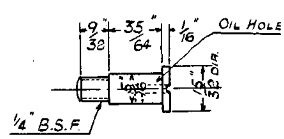


Fig. 7. Pin for planet wheels, 2 off, cast steel, hardened, ground and lapped.

to leave the grinding until you have hardened, riveted together and ground the bore of the planet wheels and pinions, as it is much easier to grind the pins to fit the bores than it is to grind the bores to fit the pins.

(To be continued)

*The History of "Tich Too"

Concluding the account of the development of a miniature flash-steam hydroplane

By H. J. Turpin

REVERTING to the valves, these are shown in detail in Fig. 22. The determination of the valve system was carried out by constructing a wooden model five times full size. An outline drawing of the cylinders, cylinder-heads and crankshaft was made on a sheet of three-ply and all the moving parts constructed to rotate upon the correct centres. Wooden eccentrics were made adjustable for position in respect to the crankpin and valve-rods adjustable for length, and when this makeshift mechanism produced the correct timing for each valve, all the relevant data was taken by measurement and recorded. Fig. 21 is a pictorial record of that data.

Fig. 22 takes the diagram a stage further, and shows the left cylinder, eccentric and valve. The valve is $\frac{3}{8}''$ diameter and $1\frac{3}{8}''$ long, and has the passages cut as shown in the sectional view. The steam and exhaust ports in the cylinder-head on the valve diameter are 0.06″ wide × 0.40″ long, while the port into the cylinder is 0.075″ wide × 0.40″ long. The first two ports intersect the circular steam and exhaust passages respectively.

As before mentioned, both connecting-rods work on one crankpin which is made solid with the crankshaft. In fact, the crankshaft is one of those few brainwaves that ever work out successfully in practice. The ideas underlying its design are :—

1. To get the main bearing as close to the piston thrust as possible.
2. To transmit torque with a minimum of bending.
3. To use ball bearings.
4. To use the outer race of a substantial bearing as part of the flywheel.
5. To provide an overhung crankpin and so obviate split big ends of connecting-rods.

The crankshaft can be seen in Fig. 19, the flywheel being sectioned to show construction of main bearing. The outside diameter of the flywheel is $1\frac{1}{2}''$ and carries, inside, a Skefko self-aligning bearing RL4—$\frac{1}{2}''$ bore, 1 5/16″ outside dia. This in turn is pushed over a hollow spigot secured to the transom B, of the engine frame, the shaft proper passing through the centre hole and clearing it by 0.03″ on diameter. The rear end of the shaft in turn is carried in a 6 mm. Skefko self-aligning bearing No. 13301 held in a steel housing which is secured to the rear transom, C. This crankshaft has proved free from any trouble, which is very creditable seeing that the engine ran under racing conditions almost every week during the summer of 1938. The only part I renewed for *Tich III* was the main ball-bearing in order to ensure beginning the next season with it in a new condition.

* *Continued from page* 223, "*M.E.*", *February* 29, 1940.

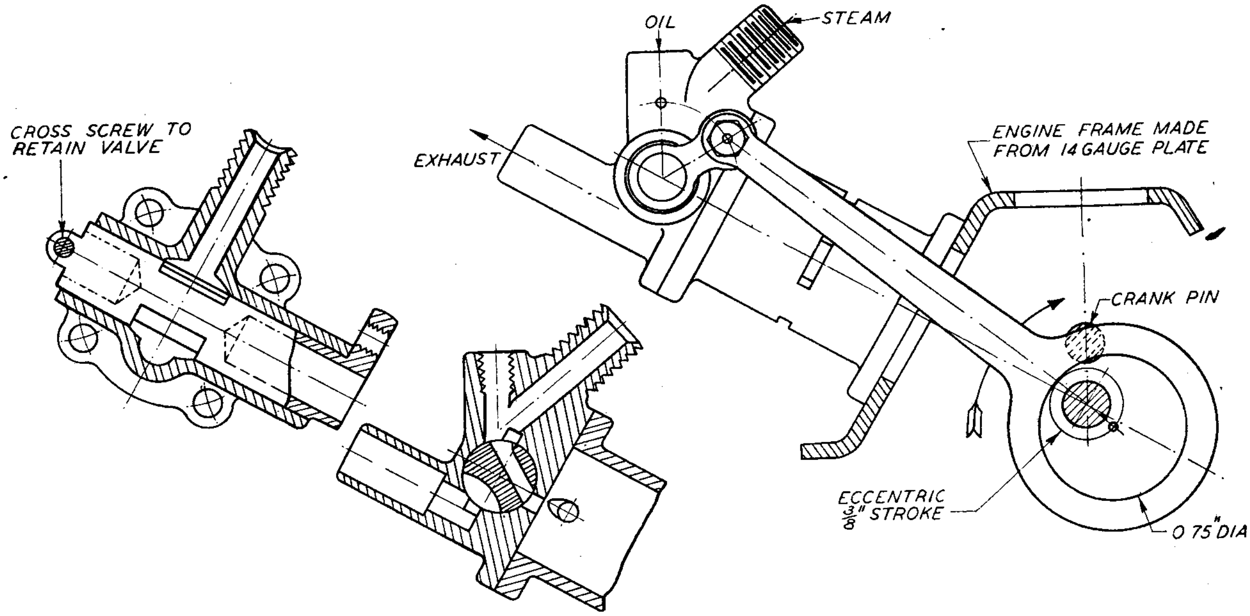


Fig. 22. Sections through left valve, and method of operating by closed link rod.

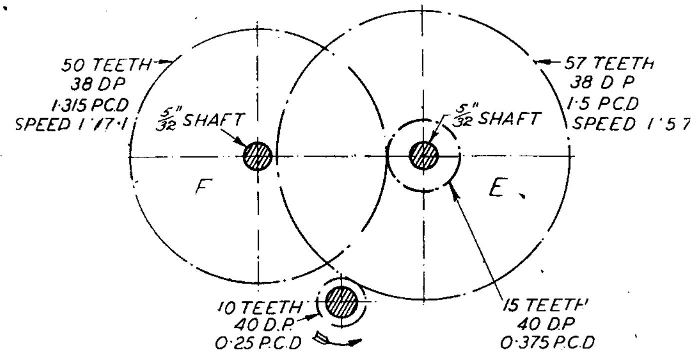


Fig. 23. Dimensions of geared drive to two layshafts.

As I distinctly dislike split-rings of any sort, the valve-rods, as well as connecting-rods, were made each in one piece. This, however, necessitated an assembly method of threading everything on the shaft. To permit of this the eccentrics had to be made with only one flange, and itself is of special construction. Rear eccentric has a rear flange only, is machined from solid bar, and takes the drive from crankshaft by a 2 B.A. set-screw. Its general thickness is 0.03", except boss, which is 0.06" thick.

The front eccentric is driven by a pin sweated to the web of the rear eccentric while interposed is a brass disc 20 gauge thick to serve as a flange to separate the two valve-rods.

Drive for Pumps

A secondary shaft 3/16" dia. with crank and a small crank-pin to engage a hole in the end of the main crank-pin is used to transmit the power to the layshafts. This also is shown in Fig. 19. There are two layshafts, that for the water pump marked E and for the oil pump marked F, both driven by the spur gear train shown in Fig. 23, mounted on the front transom A, Fig. 19, which is detachably screwed to the engine frame principally for the assembly of the mainshaft.

It will be noticed that the two large gears are 38 D.P. These are standard Meccano gears and mesh near enough for all practical purposes with the 40 D.P. pinions. Relative speed ratios are marked against each shaft. In case there is any doubt as to the wearing qualities of this gear train, I would mention that after a season's running there is practically none and you would have to get a reading glass to detect it. The secret is to get the pinions case-hardened to a glass hard surface, and to provide as full engagement as possible with the brass gear wheels.

Both layshafts have their front bearings in transom A and rear bearings in transom C. This bearing span gives them great steadiness and, in the case of the water pump shaft E, which has a $\frac{1}{4}$" dia. ball-bearing at its rear end, absorbs a minimum of power when driving at full power.

Pistons are of cast iron and made after petrol engine design, but no rings are fitted. They are provided with hollow gudgeons 5/32" dia., having brass inserts at the ends. Connecting-rods are of duralumin, and of simple but stout design. Both these items are shown in Fig. 24 and, while they have done a whole season's work, the working surfaces are just polished and I am using them without alteration in *Tich III*.

Wearing Properties

Now this question of wear, or lack of wear, is a very important one, so I will enumerate the materials which have proved to have great resistance to wear, bearing in mind that adequate lubrication and full load are always implied.

Nickel-chrome valves working in a fine grain cast-iron cylinder-head.

Fine grain cast-iron pistons in a nickel-steel cylinder.

The above combinations withstand highly superheated steam.

Gudgeon-pin of silver steel, hardened and tempered to a light straw and polished, working in a duralumin connecting-rod, big-end being on a crankpin (integral with crankshaft) of mild steel thoroughly case-hardened.

Pinions of mild steel thoroughly case-hardened and gear wheels of brass.

Valve-rods of duralumin and eccentrics mild steel case-hardened.

The log contains little comment on the engine throughout the season, which indicates that, on the whole, it proved itself satisfactory.

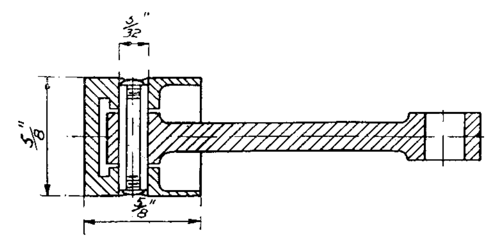


Fig. 24. Cast iron piston, duralumin connecting-rod and floating silver-steel gudgeon-pin.

On dismantling, it was found that the greatest wear took place in the valve chambers in the cylinder-heads. These had worn slightly oval due to the push-and-pull effect of the valve-rods on the valves. Re-lapping and new valves have been the remedy for *Tich* III.

Boiler

The boiler followed quite orthodox lines and consisted of 18 ft. of $\frac{1}{4}$" dia. steel tube wound into twin coils without a joint. Inside diameter at lamp end $1\frac{3}{8}$" and at front end $1\frac{1}{4}$". Overall length of coils 7". After several runs it was realised that while the flame travelled the whole length of the coil it made insufficient contact with the tubes, so an

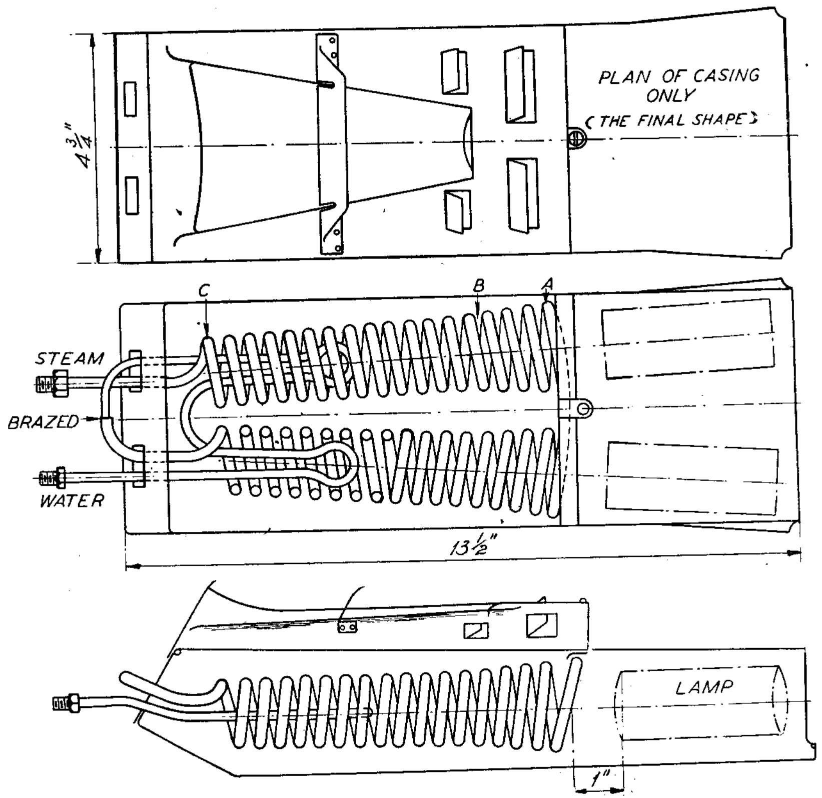
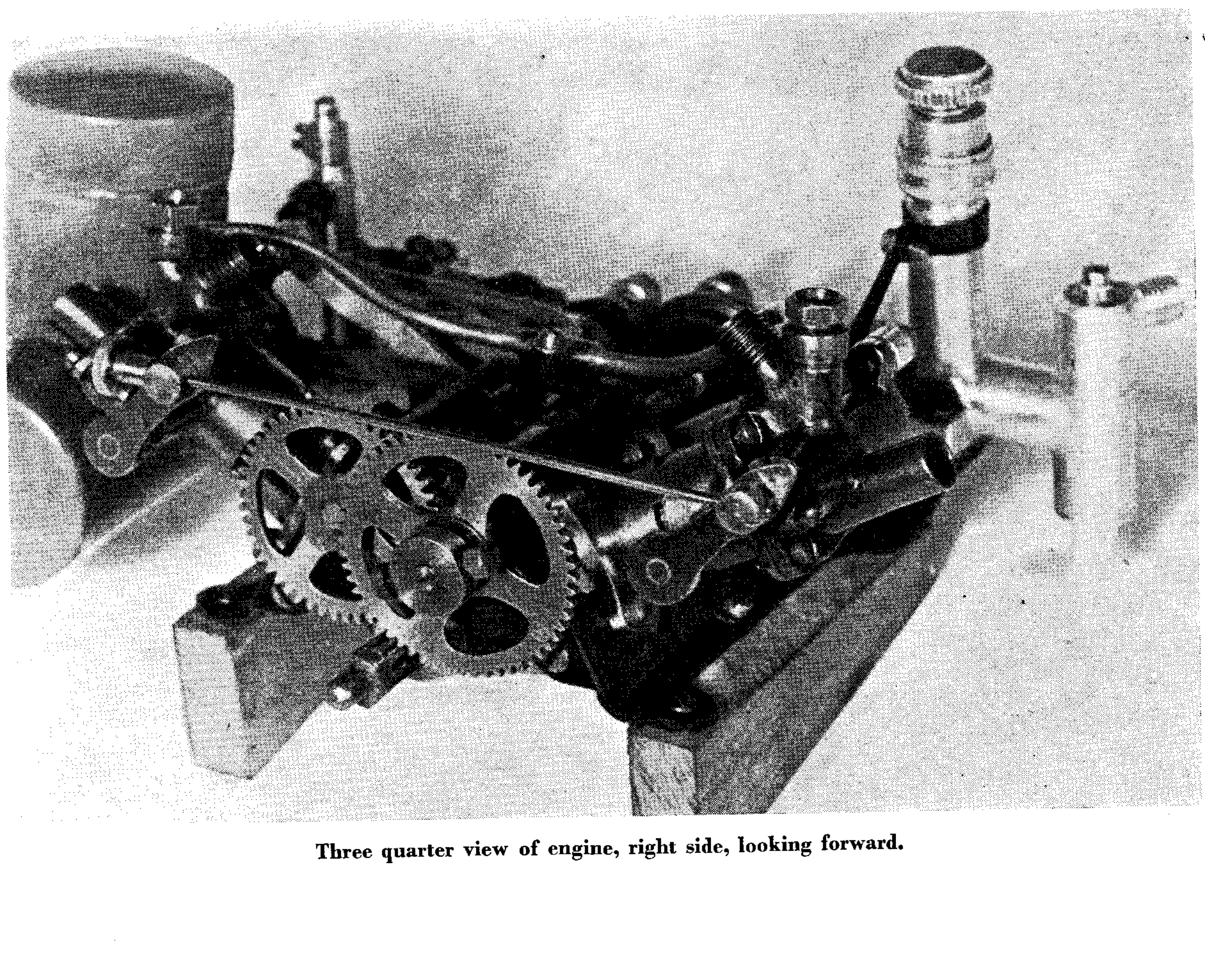
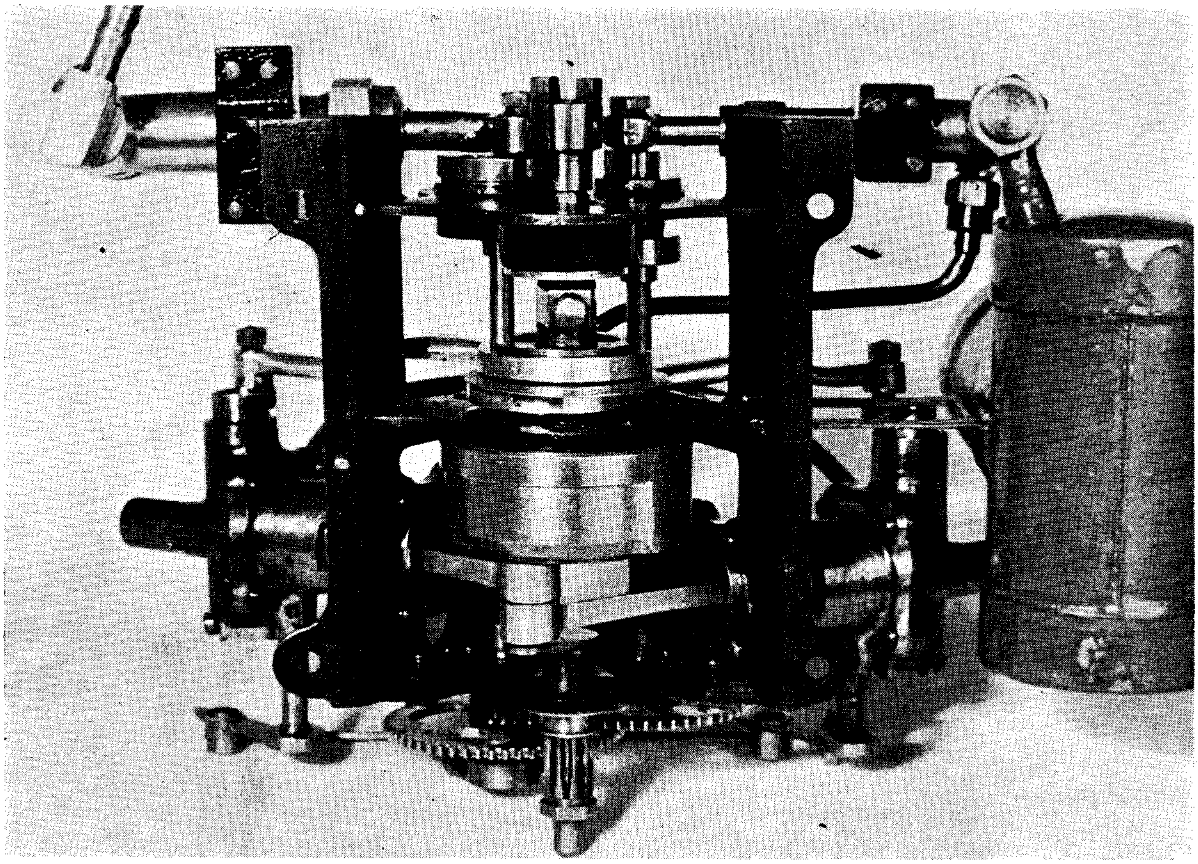


Fig. 25. The boiler, showing the pre-heating element.



Three quarter view of engine, right side, looking forward.



An under-side view of complete engine, showing oil tank on right.

alteration was made, and the log for 22nd May reads :—

"Wound each coil of boiler round a smaller former so that diameter at A is still $1\frac{3}{8}$", reduces rapidly to $1\frac{1}{8}$" at B and to 1" at C. This is an effort to get better contact with flame. Each coil now has 18 turns as opposed to 15, and is one inch longer in consequence.

"In addition, I have introduced a pre-heating element which consists of about 20" of 3/16" dia. tube formed into two loops, one inside each coil (see Fig. 25). This also has the effect of spreading the flame slightly. The original connection was severed and pre-heater joined to original tube. Other end joined up to water pump."

And the reply as recorded on 5th June :—

"All alterations for this trip proved satisfactory. There is a distinct improvement today mainly due to better steaming qualities of boiler and speeds were much higher. For one lap on one trip *Tich Too* did 27 m.p.h., the highest yet recorded. This speed, however, brought to light other troubles. . . ."

This brings us to the end of what is, after all, a brief survey of only some of the experiences a speedboat merchant encounters in a season's running. A full survey would fill volumes. My difficulty has been to keep the story down to manageable limits.

In conclusion of this story of *Tich Too*, I would repeat that an endeavour has been made not to follow the leader blindly. As you will have already gathered I have paid dearly for so doing. At the beginning of the season it was realised that little of competition work would be seen, and this turned out to be true ; but it is hoped that the foregoing experiences will have served a very useful purpose. My diagnosis of troubles that have developed may not be to the liking of other speedboat folk, and opinions may be considered as false, but I do not mind that at all. What does concern me is that they do permit me to progress a step farther with the development of *Tich* III.

[This article of Mr. Turpin's has aroused a great deal of interest amongst our readers, many of whom have written to ask for more. The experiences gained from *Tich Too*, of course, will be of inestimable value in settling the details of the hull and engines for *Tich III*, and, no doubt, are being used. But we hope that, in due course, Mr. Turpin will give our readers the benefit of entries in *Tich III's* logbook. Model engineers, usually, seem to shun the publication of experiences, especially when the results of experiments are not successful; but records of failures are often of the greater value to other experimenters.—Ed., "M.E."]

The "Bat"

By "L.B.S.C."

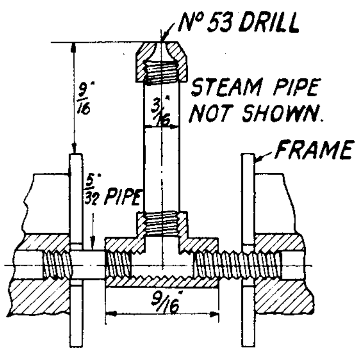
Steam and Exhaust Connections

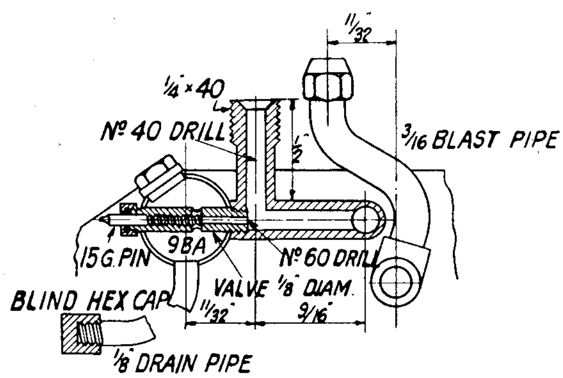
THE next job on the "flying mouse" is the first stage of what our trans-atlantic cousins always associate with "the man who forgets his tools." I always recollect, with a smile, the American engineman who was especially interested in "Sir Morris de Cowley" at the New York S.M.E. Exhibition ten years ago. He asked if he might "take a peek" in the front end, so I opened the smokebox door and put the little locomotive into his hands. Holding it as if afraid it would bite, he took a long look in the smokebox, and then under the leading end; turned to me and said: "Say, boy, how the (town in Norway) did you do the plumbing?" The verbal and facial expressions he put into that remark would have got him a job at Hollywood! Admittedly, piping up a little "O" gauge outfit is ticklish, but anybody who follows the instructions set out below, should not have any great difficulty. If the pieces of copper tube are softened by heating to redness and plunging into water, they will bend as required; and if plenty of ordinary cutting oil, as used for turning in the lathe, is applied to pipe and die when screwing, good untorn threads will be the reward.

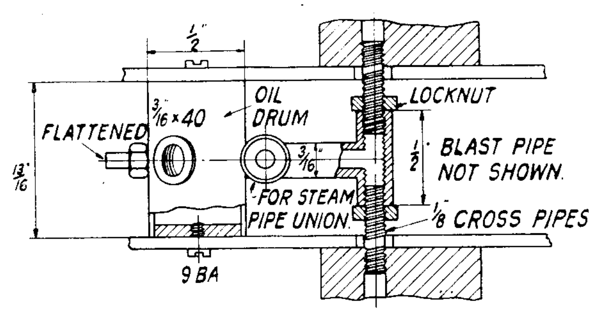
Exhaust Tee and Blast Pipe

Some of our advertisers sell little cast tees (also elbows, crosses and other connections); one may be turned from solid, using a bit of $\frac{1}{4}''$ by $\frac{3}{8}''$ flat brass rod, chucked in four jaw $\frac{1}{8}''$ out of centre, so that the ends can be turned round to $\frac{1}{4}''$ diameter, leaving the stem of the tee at one side. Alternatively a tapped bush, 9/16″ long, can be made from $\frac{1}{4}''$ round brass or gunmetal, and a short piece of the same sized rod, also tapped (known to pipe fitters as a female nipple) silver-soldered to the side of it. Anyway, the result, whatever the means, should be as sketch.

The two cross pipes are 7/16″ lengths of 5/32″ copper tube, thick enough to take a thread, say 22 gauge. One has $\frac{1}{8}''$ of thread on each end; the other is screwed full length. Screw one end of the former into the tee as far as it will go, see sketch, and run the other one into the opposite side almost full depth, just leaving enough out, to catch hold of and turn with thin-nosed pliers. Slack the fixing screws of one of the cylinders, so that the tee, with pipes attached, can be inserted between frames and screwed into the exhaust-hole. Tighten up cylinder screws, then run the other pipe out of the tee into the exhaust hole on the







Steam and exhaust connections for the "Bat."

opposite cylinder. A smear of plumbers' jointing may be applied to the threads. A lock nut may be put on the fully-screwed pipe if desired; but if this is done, the tee will have to be made shorter, or it will not go in place. I do not usually bother about locknutting exhaust pipes, as the tee cannot turn when the smokebox is on, the blastpipe preventing it; whilst no exhaust steam gets past the threads, it all goes up the blastpipe.

Owing to the close quarters, and the chimney being ahead of the cylinder centre line, we shall have to put a permanent wave in the blast-pipe; but as you can—literally—bend softened 3/16″ copper tube around your thumb, this presents no difficulty. The easiest way to do it, is to put the bends in a bit of tube longer than needed, which gives a bit to catch hold of at each end whilst bending; then cut to length (a full inch) and screw each end. The blast nozzle is made like a union nut, from ¼″ hex. brass rod. Drill it No. 53 for a kick-off; it will probably need adjustment after a trial run or two, in order to get best results on the road. No two engines are exactly alike, big or little; they all have fads and fancies. The top of the nozzle should stand 9/16″ above top of frames, and should be approximately 11/32″ ahead of the cross pipe. The exact adjustment is made after fitting the smokebox, so as to bring to nozzle exactly under the chimney liner.

Steam Tee

This may be a casting, or turned up from ½″ by 3/16″ flat brass rod; also, a ¾″ length could be sawn and filed easily enough to tee-shape, leaving both arms and stem square. The head of the tee is drilled right through No. 40, and tapped ⅛″ or 5 BA. The stem is also drilled No. 40, into the cross hole, and the end is tapped likewise. The connection for the steam pipe from the boiler, is silver-soldered right at the end of the arm, and consists of a ½″ length of ¼″ round rod, ¼″ of which is screwed, the end deeply countersunk with a centre drill, and a No. 40 drill put right through.

The connecting pipes to steam chests are 7/16″ lengths of ⅛″ pipe screwed to match the thread in the tee. Put ⅛″ of thread on one end of each, and ¼″ on the other end. Make a couple of locknuts about 1/16″ thickness, from ¼″ hex. brass rod, screw them on the longer threaded ends as far as they will go, then screw them into the tee. If the tee, with pipes attached, is held centrally between the cylinders, the pipes may be screwed out of the tee, into the holes in the steam chests. Do not tighten the locknuts yet, as we have to fit the lubricator before the final tighten up. It cannot be connected to the tee unless the latter is raised clear of the frames.

Lubricator

Apart from being "watchmaking in excelsis," a mechanical lubricator for this size of locomotive, would be a bit too fragile to stand up to a real job of work; so we shall have to fall back on the hydrostatic type. Though the feed is not so regular as a "pumpette," a little drum oiler, with a regulating valve, can be relied on not to let the valves and pistons go short of a drop of the needful. A suitable arrangement for the "Bat" is shown in the sketches. The drum, or oil container, consists of a piece of ½″ tube, brass or copper, about 24 gauge and 13/16″ long, just right to fit nicely between frames. A disc of brass or copper 1/16″ thickness, is silver-soldered into each end. A little bush, made from ¼″ rod and tapped 3/16″ by 40, is silver-soldered into one side, to accommodate a filling plug. About an inch of ⅛″ copper tube is silver-soldered into the bottom, to act as a drain pipe for condensate water; the end of this is screwed, and fitted with a blind cap made from 3/16″ hex. brass rod, as sketched.

The regulating valve is a weeny-weeny affair, but easy enough to make if you are careful. *Modus operandi* as follows. Cut a piece of ⅛″ brass rod ¾″ long. About 5/16″ from one end, drill a No. 50 cross hole. That wants a bit of doing, for a start, says our friends the tyros; the drill always wanders away to one side, on round stuff. Well, file a little flat on the rod, and make your centre pop in the middle of the flat, and then the drill will not wander. Chuck the bit of rod in the three jaw, with the shorter end outwards; face the end, centre with a smallest-size centre drill, or a home-made arrow-headed drill, and drill No. 60 right into the cross hole. Put a few threads, either 5 BA or ⅛″, on the end of the rod.

Reverse in chuck; face, centre, and drill No. 53 into the cross hole, letting the drill just touch the end of the No. 60 hole on the opposite side of the cross hole, to make a true seating for the valve pin. Open out the hole about half its length with No. 48 drill, and tap the remaining half 9 BA. Screw the end as before, and make a little nut, like a union nut, to go on the end, using 3/16″ hex. brass rod, and drilling the hole No. 48. The valve pin is an inch of 15 gauge spoke wire, screwed 9 BA for about ⅜″ length; the screwed end is pointed. This can be done by holding a fine file diagonally at the end of the threads, whilst the lathe is running fast. The other end is flattened, so that it can be turned with pliers, or a key made from a bit of steel rod with a slot sawn across the end ("negative" screwdriver?). Of course, a little wheel might be fitted to the valve pin, but it would prevent a cover plate being fitted in front of the smokebox, Inspector Meticulous would promptly send in a report about the comparatively big hand wheel spoiling the appearance of the front end, and the fat would be in the fire once again. Pity a poor long-suffering locomotive-building instructor!

Drill a couple of ⅛″ holes on opposite sides of the drum—when the drill pierces one side, let it carry straight on through the other; then they are sure to be in line! Put the valve through the holes, with the screwed ends sticking out an equal amount each side; remove the valve pin and nut, and either silver solder or soft solder the valve in position. Replace valve pin, and pack the gland

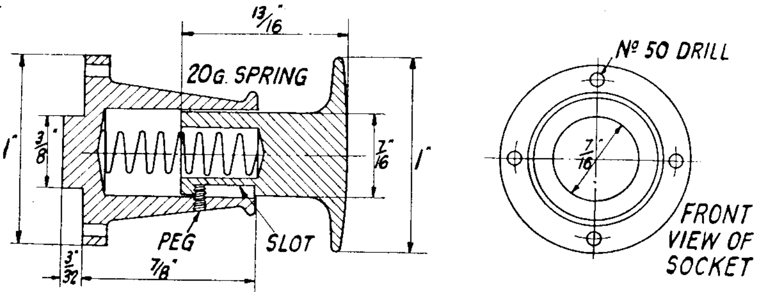
with graphited yarn. To assemble and fix, push the blastpipe back out of the way; the tee will turn, and allow this being done. Then turn the steam tee until the stem is nearly vertical, and stands clear of the frames. Put a smear of plumbers jointing on the threads of the lubricator valve, and screw it into the tee, until right home, with the drum horizontal, and the filler plug at the top; or rather, what will be the top when the lubricator is in correct position. Then push the stem of the tee down again until it is horizontal, and the oil drum just below the top of frames, see sketch. Drill a No. 53 hole each side, clean through frame and end of lubricator; lift the latter clear once more and tap the holes 9 BA. Open out the holes in frame with No. 48 drill, replace lubricator in correct position, and put in a couple of jointing-smeared brass 9 BA screws. Tighten up the two locknuts against the tee, applying more "dope" to the threads; bring the blastpipe back again to correct position, and you are all set.

MISS TEN-TO-EIGHT

Conclusion

The way in which this locomotive is finished off, depends to a large extent on the builder's requirements. Some who are only interested in having an engine that will pull and go, cut down "trimming" work to absolute necessaries; others who have a "super-detail complex," will adorn her with every possible accessory that could be copied from the original engine. For my own part, I like to strike the happy medium, as it were, leaving out little twiddly-bits that get knocked off or damaged in hard service, but including things that any engineman would at once miss if they were not there. Different folk, different fancies!

Several readers having asked for a sketch of a buffer that can be bolted to the beam by its flange, as in big practice, and having no projecting back spindle to foul the tender frames, here is one. Older readers may recollect that about 35 years ago, the body that is responsible for railway regulations, condemned the dumb-buffered goods wagon, then existing in large numbers, and fixed a time limit for converting them to spring-buffer type. Several wagon-building and accessory firms immediately began to provide self-contained buffers without spindles, which could be bolted direct to the wagon beams; and the buffer illustrated here, is a copy of one of those made, to the best of my recollection, by the Turton and Platt folk, except that it has a spiral spring instead of volute. The sizes are given on the sketch, the job being merely a matter of plain turning and drilling, requiring no detailing out. The head is turned from 1" steel rod, and the socket may be either brass or steel. The 3/32" slot in the head may be end-milled with a dental burr, like cutting a port, or a flat may be filed on the stem, as the head does not come out far enough to show it. The peg is a bit of 3/32" silver steel, screwed in and filed off flush, after the spring of 20 gauge wire has been inserted. The holes in the flange for the 1/16" hex.-headed fixing screws, should be slightly pin drilled, to give the heads a fair seating. The $\frac{3}{8}$" spigots at the back of the buffer, fit the drilled holes in the tender beam.



The spindleless buffer for "Miss Ten-to-Eight."

Drawhooks can be filed from odd bits of frame steel, and need no detailing. Screw coupling shackles can be made from 13 gauge spoke wire. The blobs on the end, in which the swivels run, are easily formed by filing away half the diameter of the wire for about $\frac{3}{8}$" length, bending it into an eye, and then brazing or silver-soldering it. Fill the eye right up, and then poke a 3/32" drill through; the result is the same as a solid forged eye. The swivels can be made from 3/16" steel, turned down to 3/32" at the ends, to run in the eyes. One is drilled No. 40, the other drilled 44 and tapped 6 BA. The screw is turned from 5/32" steel, one end screwed 6 BA to fit the tapped swivel, and the opposite end turned down to run in the No. 40 hole in the other. Push it through, and burr the end over, but leave it free to revolve. The ball spindle, of 3/32" wire with a 3/16" ball on it, is screwed into the plain part between screw and shoulder. The complete coupling, on a $3\frac{1}{2}$" gauge engine, should be approximately 2" long.

The steps, the shape of which can be seen in the general arrangement drawings, are made up from 16 gauge steel sheet, and screwed or riveted to the drag beams and running boards. The guard irons are filed up from 3/32" steel and riveted or screwed to the frames. Handrail knobs in German silver are supplied by our advertisers, and are not really worth the trouble of making, although if desired, they could be turned from 3/16" round rod with a form tool made from an old 6" flat file, and the stems screwed 8 BA. If the boiler barrel is lagged, which may easily be done by wrapping 26 gauge brass or steel sheet around it, and holding same in place with bands of 30 gauge spring steel, the knobs may be screwed right through the cleading sheet into the boiler, with plumbers' jointing on the threads. The handrails themselves

(*Continued on page* 278)

Railway Practice

By Chas. S. Lake, M.I.Mech.E., M.I.Loco.E.

Locomotives and Wagons for the B.E.F.

ORDERS for 240 locomotives and 10,000 wagons have been placed in this country for war service overseas. The engines are of the 2-8-0 freight type corresponding to the "8F" class of the L.M.S. Railway. They have cylinders $18\frac{1}{2}''$ diam. by $28''$ stroke, coupled wheels $4'\ 8\frac{1}{2}''$ diam., a total heating surface with superheater of 1,895 sq. ft., grate area 28.65 sq. ft., steam pressure 225 lb. per sq. in., and weight in working order complete with tender of 126 tons 15 cwt.

Some few variations are being made in the equipment of the locomotives for service on the French railways, the Westinghouse brake, for instance, being used instead of the automatic vacuum. The tyres are being turned to French instead of British standards; speed indicators are being fitted and the drawhooks, buffers and couplers will accord with French standards, with the addition of safety chains. No water pick-up gear will be fitted; the engine frames will be of mild steel 1 1/16" thick, instead of high-tensile steel 1" thick, as on the L.M.S.R. The engines, it is anticipated, will weigh slightly more than those of the same class used in England.

The wagons are of French design. They are covered vehicles on four wheels, having wooden bodies; the tare weight is 12 tons, and the carrying

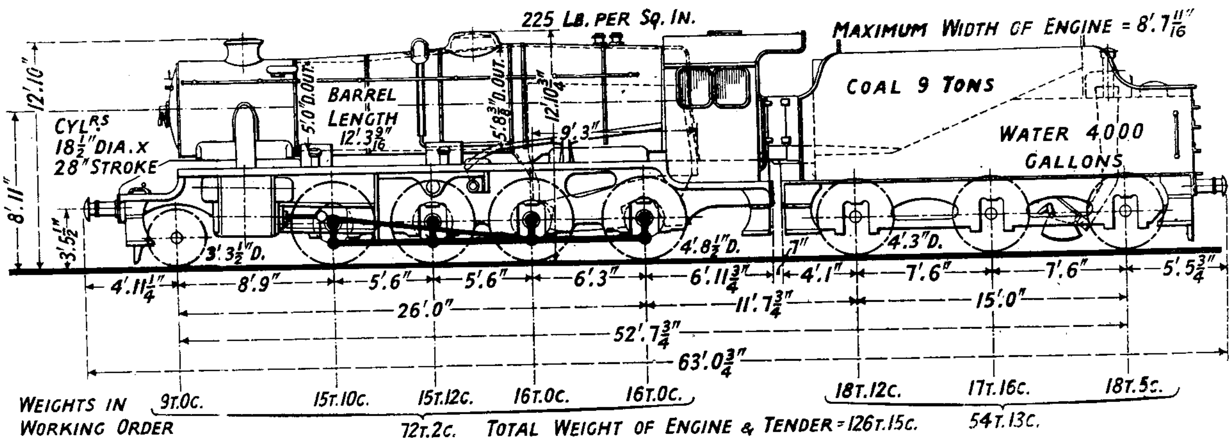


Diagram of L.M.S. type 2-8-0 locomotives for service in France.

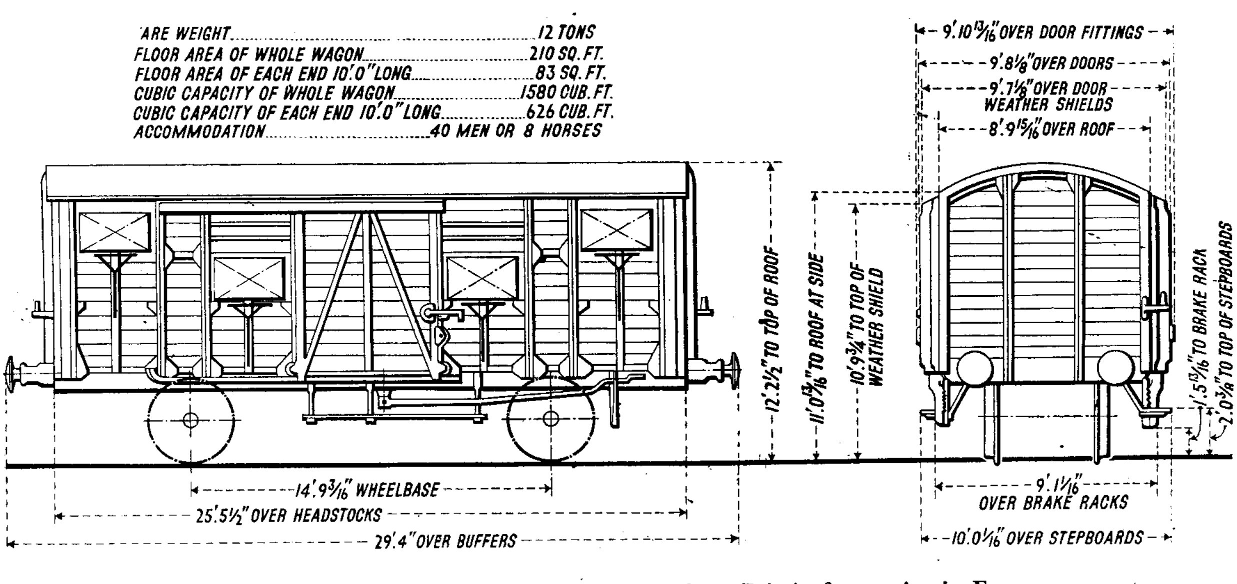
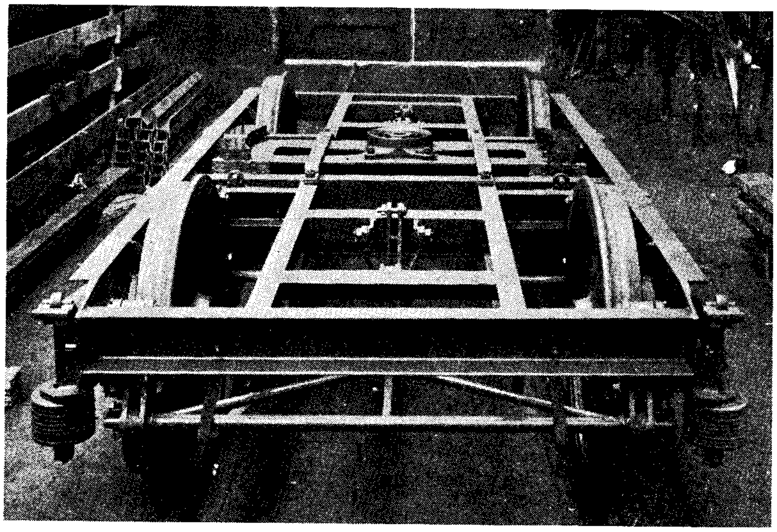


Diagram of the 20-ton covered wagons built in Britain for service in France.



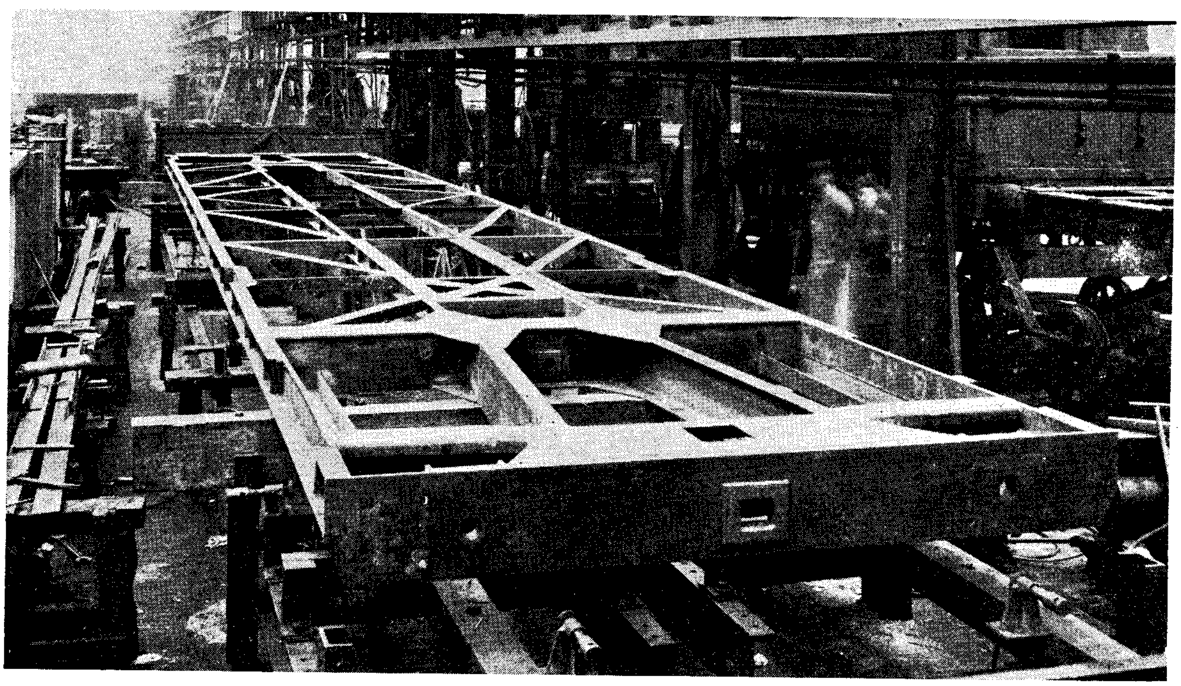
Bogie for L.M.S. articulated coaches.

capacity 20 tons. Each can accommodate forty men or eight horses. The wagons will supplement the French stock, and being of a standard pattern will simplify operation in France.

Building Welded Railway Carriages

Stages in the construction of main line passenger carriages are shown in the photographs reproduced herewith. The vehicles are of the articulated type in which three bogies are used for a pair of coaches instead of the usual four, and in the photograph are seen in the Derby works of the L.M.S. Railway. Welding is largely resorted to in the construction and assembly methods and views are given of the top side of the underframe and the body, also a view of the centre bogie.

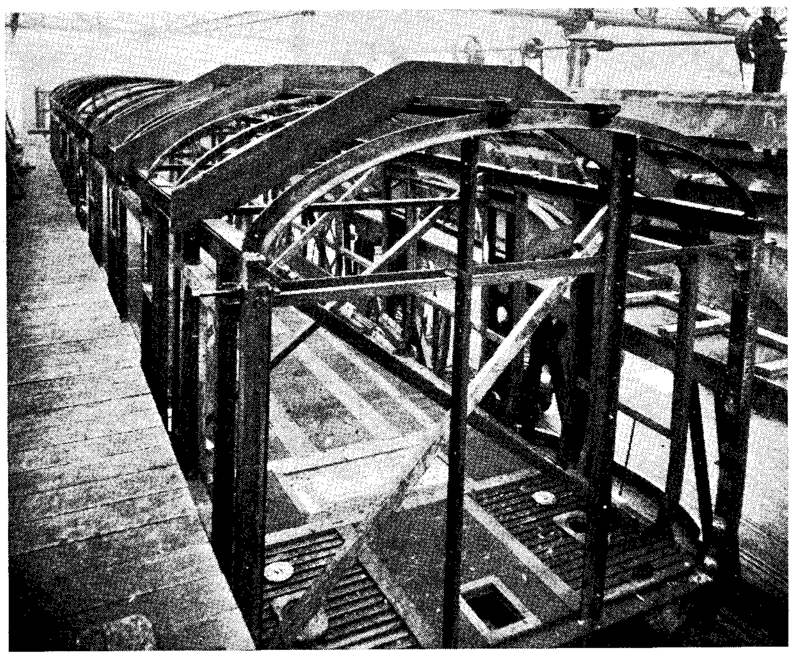
The design of the body and underframe is arranged so that the solebars and cantrails are combined as one member and the trussed longitudinals as another. The bogies are constructed of mild steel and welded throughout. The underframe is assembled in a jig which ensures every component part being in correct alignment and matching with the rest. The welders then commence operations and later the framing is ready for the body, and finally for mounting on the bogies.



Welded underframe for articulated coaches, L.M.S.R., shown in course of construction in Derby Works.

Jigs and templates are also employed in the construction of the body sides and roofing and as noted, raised platforms are provided for the workmen on each side. The roof panels are made of galvanised steel sheets 1/16 in. thick, and the body side panelling of charcoal steel and of the same thickness. The back body side panel is welded to form a continuous sheet of metal without any rivets or bolts and the long experience and skill of the operators result in producing a finish free from buckling or other irergularity in the surface. The roof sheets are welded in position to the roof members which latter are of light constructions and secured to the cantrails by welding. Wooden templates or gauges are used to ensure that the work is true to shape and dimension.

The floor sheets are corrugated and welded directly to the underframe members. The corrugations are filled in with cork, on top of which lino is laid. The space between the body side and roof panelling and the interior finishing is ventilated to allow a through current of air in order to eliminate condensation.



L.M.S. articulated trains. One of the coach bodies during assembly.

The methods outlined above result in the building of a set of articulated coaches at a much reduced weight as compared with that of a similar set in which welding is not employed. The weight of 10 L.M.S. standard 57 ft. vestibule cars is 300 tons, and that of a 10-coach articulated vestibule train 245 tons, a saving of 55 tons per train. The bulk of this saving is, of course, attributable to the smaller number of bogie trucks, but the welding process is also responsible for a measure of economy in the weight of the trains.

Locomotive " Blow-down " Arrangements

A correspondent, writing from Belfast, enquires as to the exact meaning of the term " boiler blow-down " in connection with locomotives, and the purpose achieved thereby. He is under the impression, he says, that the process is one that is mostly undertaken in the running shed, but, in some cases at all events, is performed whilst the engine is running.

In reply, it may be stated that the " blowing down " of a locomotive boiler is part of the process employed in the shed for cleaning out the interior of the boiler. When performed in the shed, the boiler is first blown down, then washed out, and finally refilled with fresh water in readiness for further service. In many cases, a hot water system and apparatus is employed which avoids the risks attending violent changes of temperature which injure the plates, stays and tubes. With the hot water method, the boiler is blown down, washed out with hot water and filled up also with hot water, the temperature of the water being about 180° for washing out and 210° for filling up.

The " continuous blow down " system employed for locomotive boilers under running conditions, in the main, provides a means of preventing the boiler from priming, or " foaming " as it is sometimes called. This is usually aggravated when feed water which has been subjected to a chemical softening process is used.

The apparatus in a general way comprises an automatic water-valve and a main stop-plug mounted together in a casting secured to the back of the boiler together with the necessary piping and connections to carry away the discharged water. By this means a definite and limited quantity of water is blown out of the boiler continuously so long as the regulator is open, the water being discharged on to the ballast through a cooling coil immersed in the tank of the tender.

Interesting Locomotives for New Zealand

The North British Locomotive Co., Ltd., has recently completed an order for forty mixed traffic locomotives of the 4-8-2 type for the New Zealand Government Railways. The engines are streamlined in a modified form and present a very striking appearance. The writer has received photographs and drawings of the new class from the builders, and these will be submitted to the Editor for reproduction in THE MODEL ENGINEER in the near future.

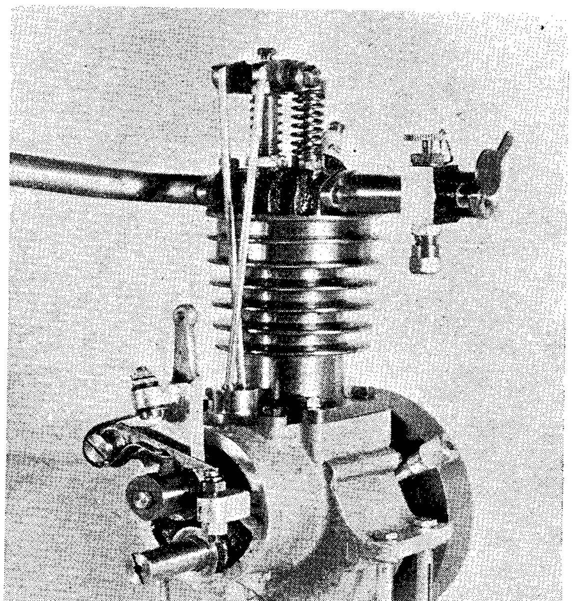
"Advice to Beginners!"

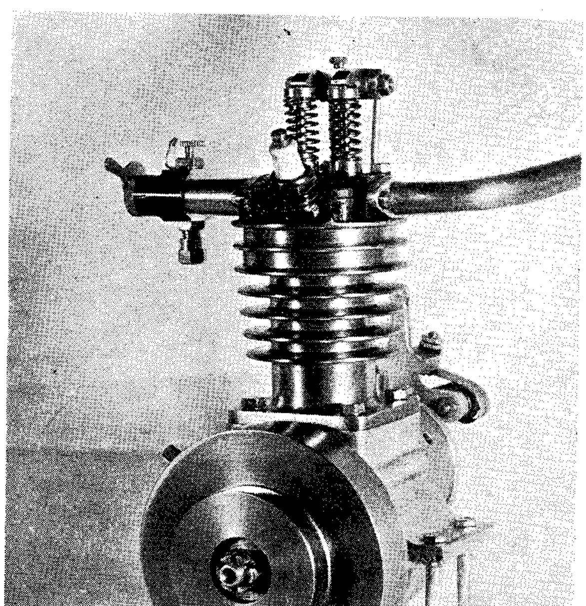
Some hints, based on replies to recent queries, for the assistance of readers who contemplate taking up the construction of model petrol engines

By Edgar T. Westbury

MANY times in the past I have been seriously taken to task by some of the more advanced readers because of my failure to cater for their particular needs, in respect of high-efficiency engines especially. But while I have always been deeply interested in the problem of obtaining the utmost power from an engine, and also realise that a certain proportion of my readers are vitally concerned with this problem, I have long come to the conclusion that both the production and tuning of a high-efficiency engine are very largely individual matters, and that beyond helping readers to keep in touch with modern developments in design, there is little that I can do in the matter. The majority of highly successful engines which have been built by readers in recent years have been of quite straightforward and conventional design, and the few exceptions to this rule appear to have owed their success mainly to the skill and perseverance of the constructor. Many attempts have been made to copy such engines more or less exactly, but in nearly every case the brilliance of the original is a missing factor, for various reasons, some of which are difficult to analyse. It follows therefore, that the task of educating readers to produce "super" engines is one that I could have very little hope of carrying out successfully, even assuming that my own ability to produce such engines was beyond question.

The requirements of the novice, who is approaching model petrol engine construction for the first time, are quite as important as those of the advanced worker, and very often present quite as difficult problems. It is not so easy as it looks to give really informative answers to elementary queries; I have met schoolmasters who will assert that the alphabet is harder to teach than algebra, and so it is with many model petrol engine problems. Much of the "advice to beginners," which is given by recognised authorities on this subject, fails utterly in its purpose, because, although pedantically correct, it lacks sympathy with or understanding of the particular circumstances of the beginner, and may thus be merely bewildering or even misleading to him. General or stereotyped solutions will never fit individual problems, and





A very fine effort by a reader, in the construction of the 15 c.c. engine described in the issue of the "M.E.," dated January 24th, 1935. An "Atom" suction carburettor is fitted.

while we are dealing in platitudes, here is another one thrown in free: it is not the person with the greatest knowledge who makes the best tutor.

Comparatively few of the many queries which I receive from beginners are of such a nature as to provide, directly, material on which to base an article of general interest, and some of them do not admit of direct replies without further detailed investigation of the particular case. In more than a few instances, this has led to a lengthy and voluminous correspondence, extending far beyond the original point at issue. Quite a number of beginners have sent me the results of their efforts, in the shape of drawings, bits and pieces, or complete engines, for inspection or comment, criticism and advice. In this way, I have been brought into close contact with the ideas, needs

Sergeant-Pilot W. Protheroe, on active service in the R.A.F., with a petrol-driven plane constructed during infrequent " quiet intervals."

and difficulties of the beginner, and claim to have been able to give him practical assistance in the majority of cases.

Among the queries which may, perhaps, be considered of general interest are the following: What is the best type of model petrol engine to make a start on? What are my chances of being able to build a successful engine at the first attempt? What equipment is necessary to build a (specified) model petrol engine? Are model petrol engines expensive to construct?

While these questions all undoubtedly concern every beginner to some extent, it is quite clear also that the answers depend very largely on individual circumstances, and cannot, therefore, be dismissed in a single sentence, or with a stereotyped reply. I propose, therefore, to examine each of them in detail, and in the light of advice already given to querists, with a view to assisting other readers who may be considering these questions at the present time.

The Most Suitable Type

The first point to be considered in dealing with this question is the purpose for which the querist intends to use the engine. Even if he has no definite intentions in this respect, it is more than probable that he will have some *preference* in the matter of types of engines, at any rate. So far as possible, I try to give readers advice which will enable them to build something resembling the type of engine in which they are primarily interested, as there is little point in building any model which will not fulfil one's personal ideas of what an engine ought to be, when it is finished. It is, of course, necessary to take into account the equipment available to construct the engine, but this point is dealt with later.

During recent years a great deal of attention has been devoted to the possibilities of very tiny engines, and I find that a very large proportion of my correspondents have aspirations in this direction, even to the extent of surpassing, in minuteness, anything yet achieved. While there is undoubtedly a great fascination in the prospect of being able to achieve the " smallest ever," the distinction is not only an extremely difficult one to attain, but is almost certain to be lost again almost immediately. My advice, which has often been criticised as over-conservative and out of date, is that if you are interested in making an engine which will work successfully, it is best to steer well clear of the infinitely small. I have seen more failures as a result of such efforts than I care to count—engines built with much patience, and no little skill, which have never worked, and never will work—and some of them not made by raw beginners, either. Yes, I know there are brilliant successes, too, but I do not think that the percentage which they represent of the total number of attempts would rate very high. In any case, I am quite convinced that the reader capable of the skill necessary to build a very tiny engine would be sufficiently qualified to need very little help or advice from me. Such engines are almost entirely examples of precise workmanship, and few of them give any real scope for subtlety in design; in other words, they only work by reason of their utter simplicity, even to the point of primitiveness, combined with the utmost mechanical perfection.

The smallest size of engine which I advise readers to tackle, as a general rule, is one of about 5 c.c., as that has a cylinder bore of a size which is large enough to bore to a reasonable limit of " scale accuracy " with the usual amateur equipment, and to lap out to still closer accuracy with the exercise of a little care and patience. From the purely practical point of view, there is little real point in making an engine any smaller, as its

power/weight ratio is certain to fall off at an alarming rate below this size.

If the beginner has a lathe of about 3″ centres, preferably with back gear, I strongly recommend starting with an engine of about 15 c.c., as all the machining work can be tackled without difficulty, and the engine (provided a sound design is selected) will have quite a substantial power, and be reasonably free from temperamental mysteries when finished. It is also possible, in an engine this size, to use a real carburettor, and introduce quite a number of other detail refinements which would be almost impossible in a smaller model.

Many readers have built engines as large as 30 c.c. on a 3″ lathe, but some of the work involved is on the heavy side, and may give the beginner a good deal of trouble.

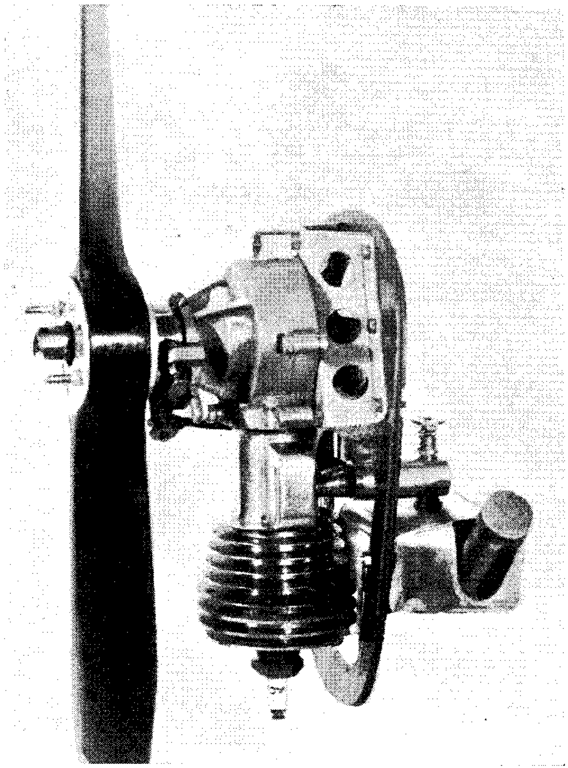
Most of the available designs for model petrol engines, in the sizes referred to, are quite simple and straightforward, and do not present any very serious problems in setting up for machining. There are, however, occasional details of design encountered where the particular circumstances of the beginner are not as carefully studied as they might be. In most cases, these details might have been considerably simplified without in any way detracting from the efficiency of the engine.

In the preparation of several of my own designs, I have tried to put myself in the place of the beginner, with the minimum of workshop equipment, and have studiously avoided the necessity for machining or fitting operations which such a constructor might find difficult, or have no idea how to set about. As to whether this course of action has been worth while, is best answered by the popularity of these engines, and the number which have been successfully constructed by beginners.

There are at present designs available for simple engines of all types within the limits of size which I have suggested, but a comparison of their respective merits or suitability is obviously outside the scope of this article. The beginner who attempts to choose for himself should remember that difficulty of construction is not always in proportion to apparent complexity or number of working parts, and that the engine which takes the shortest time to construct may possibly take the longest time to get into satisfactory working order.

Chances of Success

The beginner who attains reasonable proficiency in the art of using the lathe and other metal-working tools, may undertake the construction of a model petrol engine with full confidence of his ability to carry it to a successful conclusion, provided that he does not grudge taking pains and exercising patience. The average beginner is, however, somewhat prone to succumb to the temptation of "making do" with components on which he has made errors in machining or fitting. One thing that experience teaches is to be absolutely ruthless in scrapping jobs which are just below the proper standard of workmanship. It matters very little if we have to bore two or three cylinders or make two or three crankshafts; the cost for material will, of course, be greater, and the time taken to build the engine will be longer, but neither will be wasted, because it is all good practice in engineering; and the final result will prove the extra pains to be fully worth while.



A close-up of the 10 c.c. engine of the plane—a first effort at model petrol engine design and construction.

The beginner is advised to commence with an established design of engine, at any rate for his first attempt. He will learn a great deal about the whys and wherefores of design by working to someone else's drawings, and if he decides, after building one engine, to try and improve upon it, or design something entirely off his own bat, why, good luck to him! The results of his second venture will generally prove whether his theories are right or wrong.

I find that few constructors, whether novices or otherwise, ever build an engine meticulously according to the drawings, but prefer to modify some of the details to suit their own fancy, or with the idea of improving on the original. There is no objection whatever to this method of expressing individuality, but it is most important to know what details can be altered without entirely upsetting the designer's intentions. Sometimes details which appear quite insignificant may, in actual fact, be keystones in the entire edifice of the design. It is, for instance, often fatal, or at any rate, very detrimental, to tamper with carburettor

details, sizes of ports, or shape of piston crown or interior of combustion shape.

It must be admitted that the majority of attempts made by beginners to design and construct their own engines entirely fall a good way short of success. That is not because they lack ingenuity, sound principles, or even, in some cases, really brilliant intelligence. Where they fail, usually, is in detail work—the sort of detail which makes all the difference to performance, and is only taught by experience. I am very much inclined to doubt whether it is possible for anyone to design a petrol engine by pure reasoning; there are many factors in design which can be worked out by the laws of physics and mathematical calculation by those sufficiently erudite in these sciences, but there are still more factors about which only very incomplete scientific data are available, and these are of great importance in the success of the engine as a whole.

I have seen many clever designs which have failed partially or completely, in practice, through the lack of experience of the designer, and, for this reason, I strongly urge beginners who have aspirations in this direction either to serve an "apprenticeship" in the building and handling of more conventional engines, or to collaborate with a more experienced worker in the development of their designs.

Necessary Equipment

Some mention of the most suitable size and type of lathe for constructing various sizes and types of engines has already been made. The lathe is, of course, the most important and expensive single item in any amateur workshop, practically all the other really essential tools being relatively cheap, and capable of being gradually acquired as found necessary, so that their cost is spread over a considerable period. It may be said that, in this respect, the advice which has been given in these pages many times, regarding the equipment necessary for starting any kind of model engineering, applies equally in this case.

But, *inter alia,* a lathe, and a reasonably good one, is a prime necessity in any case; and if one is fortunate enough to obtain one of the really "classy" high-priced lathes which figure in the best-equipped workshops, it is undoubtedly a very solid asset. Those whose pockets are not sufficiently deep for indulging in such luxuries, however, need not despair of being able to turn out good work. In reply to many queries on this subject, I am prepared to assert, on the strength of actual evidence, that model petrol engines can be, and are being, produced successfully on the cheapest lathes advertised for model engineering purposes in this journal.

(To be continued)

Miss Ten-to-Eight

(Continued from page 271)

are made of 15 gauge German silver or drawn rustless steel wire. In case any tyro does not know how to fix boiler bands, snip off lengths of spring steel long enough to lap the barrel, plus about $\frac{1}{8}''$; punch a hole in each end with a punch made as described for punching spring plates; hold the punched end in a gas or spirit flame until red-hot, bend smartly to a right-angle with pliers, then reheat again to red, and let cool naturally. When the band is placed around the boiler, the eyes nearly meet; put a screw through both of them, with a nut on the end, and they will be quite secure. As to brake gear, a tender hand brake can be fitted exactly the same as described for "Maisie," and her vacuum apparatus added if desired; but these engines originally had the Westinghouse brake. As the air brake outfit is practically standard for any type of engine, it would be better, circumstances and our good friend the K.B.P. permitting, if this were made the subject of a separate note; so more anon.

Painting

The great essential is to get all the oil and grease off; and a good wash in petrol (if coupons permit !) outdoors, is a good way of doing it. When dry, the engine should be well rubbed over with a rag moistened with turps. Any good enamel can then be applied with a soft brush, and allowed to dry naturally, on the frames, wheels, cab, tender and other parts not exposed to heat. For boilers and smokeboxes, I have found that the best way, where "stoving" cannot be resorted to, is to fill the boiler with cold water, and apply the enamel (which should be of the heat-resisting variety as used for baths and central-heating radiators, or else a good hard gloss "synthetic," such as "Sol") with a soft brush in the usual way. Then put a small Bunsen burner in the firebox, heat the water very slowly nearly to boiling point, and keep it so for about twelve hours. When cooled off, the enamel sets hard, and is unaffected by hot oil, dirty water, finger marking or anything else; a rub with a soft oily rag, or a bunch of waste, at once restores its pristine beauty. A "tunnel" of stiff paper, cardboard or sheet metal should be placed over the engine whilst drying, to prevent dust settling on it and spoiling the gloss.

Practical Letters

"Evils" of Mass Production

DEAR SIR,—With reference to the issue of THE MODEL ENGINEER for February 22nd, I was very interested by your editorial comment on the "evils" of mass production, and must congratulate you on your spirited rejoinder to the criticism which was made. The reader in question would seem to suggest that in the workshop the amateur has nothing to learn from the professional, which, as Euclid so often remarks, is absurd.

As a professional myself, I can fully endorse your statement that the amateur can learn much from the professional engineer; on many occasions my experience in this direction has enabled me to get over little jobs in the home workshop which would have seemed insuperable without this knowledge.

Yours faithfully,
"WORKS MANAGER."

The Utility Value of Model Making

DEAR SIR,—The remarks of your New Zealand correspondent, as reproduced in your Editorial comments in the February 15th issue, call to my mind similar views which have at different times been expressed to me by my own friends, and call for a word or two from me. I feel that the advocates of the "*something useful*" idea quite fail to understand the amateur model-maker and his aims. Exactly what they mean by "something useful," and why a beautiful work of art such as a well-finished miniature locomotive, steam boat or sailing ship, should be excluded from the category of useful things, I have never been able to discover. Surely, any material object, on the production of which has been expended a vast amount of thought, time and labour *is* useful, at any rate to the maker, otherwise he would not make it. The whole question seems to turn on the precise meaning attached to the little adjective "useful." Do those who contend that the amateur's workshop should be devoted to what they call "useful" things mean that he should produce something that will serve the bodily needs of man, or which can itself be used in the production of things to satisfy such bodily needs? The essential things necessary for physical existence may be summarised as food, clothing, shelter from the elements and the means of locomotion and transport. Those who limit the meaning of the word "useful" to those things, or things constituting the means of producing them, surely forget that man has a mind as well as a body. The mind of civilised man craves for food and satisfaction in exactly the same way as the body.

Is a valuable oil painting considered a *useful* thing by those who condemn model-making? Are a wireless set, a gramophone and a musical instrument *useless* things, but wheel-barrows and sewing machines *useful* things? The first-named contribute nothing to man's physical needs, and their only use is to provide him with mental enjoyment. *The same is true of a well-finished model of a loco., boat or other structure,* which give *mental* satisfaction. They provide food for the eyes and not the stomach, and therein lies their use. In that respect, they are in the same category as the oil painting, which few will deny is a useful thing in the broad meaning of that term.

I have said nothing of personal taste. Tastes differ as widely as are the poles apart. A blind man can derive no satisfaction from an oil painting, and the sweet strains of music leave a stone-deaf man cold. These physical defects have their counterpart in the mind. What affords mental satisfaction to one man leaves another unaffected. There you have an answer to the argument in a nutshell.

The above is only one aspect of the question. Many other reasons could be urged in defence of model making, but I refrain for the moment.

Yours faithfully,
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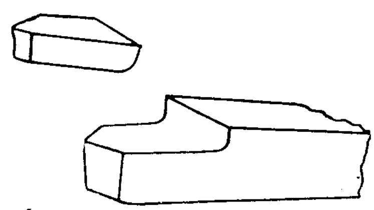
Tipped Tools

DEAR SIR,—I noticed a query in the February 15th issue with regard to tipped lathe tools; the process of tipping such tools is very interesting, and I have attempted to apply it to putting H.S. tips on carbon steel shanks, as the H.S. tools are rather expensive, especially when using tools up to $\frac{3}{4}''$ shank.

The process is as follows. For a $\frac{3}{4}''$ tool, the carbon steel shank is ground down on an emery wheel to take the tip, a depth of $\frac{1}{4}''$ being found satisfactory, the shoulder being radiused as shown. The tip is forged down from a small piece of H.S. steel and ground to fit approx. A piece of fairly pure copper (that used for electric switch fingers is satisfactory) is then beaten out to about 20 thou. thick, and a piece cut from it to fit between the tool and tip, the three pieces then being assembled and tapped down to bed the copper in. Borax is used as a flux and it will be found advisable to heat the



tool and tip, and coat with borax before brazing to avoid the swelling of the borax lifting the tip from the tool. Care should be taken to prevent borax coating the sides of the tool, because this will cause any loss of copper to eat into the steel.

The tip, copper and tool are then assembled and the tip wired on with steel wire; the tool is carefully placed in the fire and heated slowly to a white heat, at which it will be found that the copper will melt and evenly coat the space between the tip and tool. The tool should then be removed and plunged into a bath of hot linseed oil, this hardens the tip and the tool; in order to reduce the brittleness of the shank, the tool is cleaned up and laid on a red hot fire brick until the steel is blue up to the base of the tip. I have not tried air-hardening these tools, having had considerable success with the above method, finding that they stand up to cutting cast-iron at 25 ft. per min., using $\frac{1}{8}''$ cut and $1/16''$ feed, the experiment being carried out on a 9″ piston-ring quill.

Yours sincerely,
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